3.6 Flood Hydrology

This section is focused on flooding effects from the Proposed Action and alternatives. The surface water hydrology within the Klamath Basin has a complicated and complex history; however, only elements of the hydrology related to the alternatives' potential flood impacts are described in this section. Other sections of the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (EIS/EIR) discuss groundwater (Section 3.7), water quality (Section 3.2), and water supply/water rights (Section 3.8).

3.6.1 Area of Analysis

The area of analysis for this section includes the Klamath River and tributaries that define the Klamath Basin, which lies in portions of three Oregon counties (Klamath, Jackson, and Curry) and five California counties (Modoc, Siskiyou, Del Norte, Humboldt, and Trinity). Upper Klamath Lake, formed by the Link River Dam, is in Oregon and releases water into the Link River. About one mile below the Link River Dam, the river flows into Keno Impoundment/Lake Ewauna. The Keno Impoundment/Lake Ewauna is controlled by the Keno Dam in Keno, Oregon. The Klamath River begins at the outlet of Keno Dam and flows over 250 miles into the Pacific Ocean near Klamath, California (see Figure 3.6-1).

The Upper Klamath Basin is upstream from Iron Gate Dam and includes Upper Klamath Lake and its tributaries, Link River, the Keno Impoundment/Lake Ewauna, and the Hydroelectric Reach (from J.C. Boyle Dam to Iron Gate Dam). Several facilities control water supply in the Upper Klamath River, the Klamath Hydroelectric Project, and Reclamation's Klamath Project via several diversions from the Upper Klamath River (Federal Energy Regulatory Commission [FERC] 2007).

The Lower Klamath Basin includes the areas of the Klamath Basin downstream of Iron Gate Dam to the Pacific Ocean. Tributaries to the Lower Klamath Basin include the Shasta, Scott, Salmon, and Trinity Rivers. The Klamath Estuary, on the northern California coast, completes the system and eventually outlets to the Pacific Ocean (FERC 2007). Section 3.6.3.2 describes basin hydrology in more detail. The areas downstream from J.C. Boyle Reservoir are discussed in more detail because they may experience project-level impacts from the Klamath Hydroelectric Settlement Agreement (KHSA) (or alternatives). Upstream areas are discussed in less detail because these areas are upstream of the proposed dam removal activities associated with the KHSA. The potential Klamath Basin Restoration Agreement (KBRA) impacts are analyzed at a program level in this EIS/EIR.

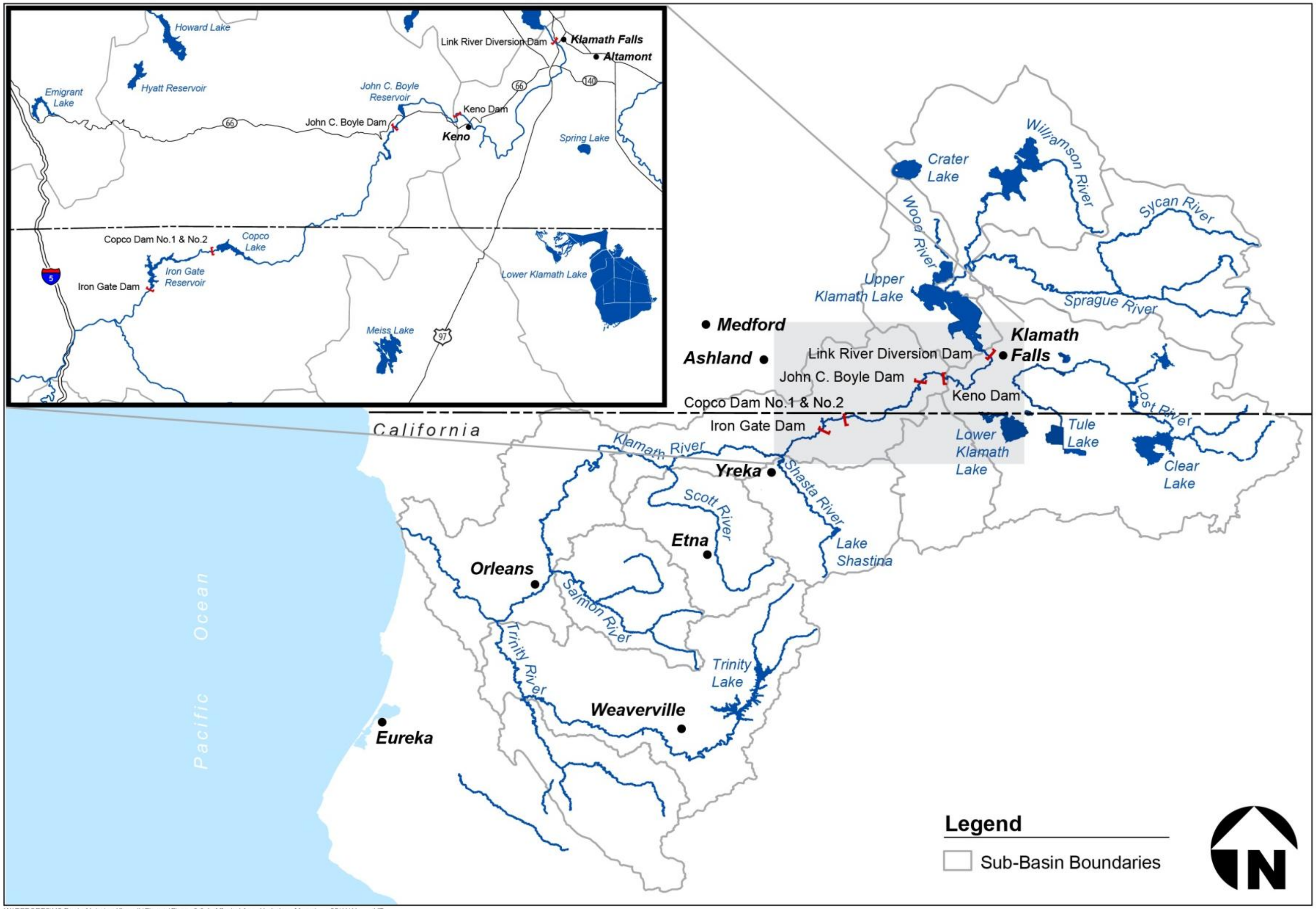


Figure 3.6-1. Flood Hydrology Affected Area

3.6.2 Regulatory Framework

Flood hydrology within the area of analysis is regulated by several federal, state, and local laws and policies, which are listed below.

3.6.2.1 Federal Authorities and Regulations

- National Flood Insurance Program

National Flood Insurance Program

The National Flood Insurance Program (NFIP) is regulated by the Flood Insurance and Mitigation Administration under the Federal Emergency Management Agency (FEMA). The program was established as part of the National Flood Insurance Act of 1968 and includes three components: Flood Insurance, Floodplain Management and Flood Hazard Mapping (FEMA 2002).

Through the voluntary adoption and enforcement of floodplain management ordinances, U.S. communities participate in the NFIP. The NFIP makes available federally backed flood insurance to homeowners, renters and business owners in participating communities. The NFIP promotes regulations designed to reduce flood risks through sound floodplain management. NFIP maps identify floodplains and assist communities when developing floodplain management programs and identifying areas at risk of flooding.

In 1973, the Flood Disaster Protection Act was passed by Congress. The result of this was the requirement for community participation in the NFIP to receive federal financial assistance for acquisition or construction of buildings and disaster assistance in floodplains. It also “required federal agencies and federally insured or regulated lenders to require flood insurance on all grants and loans for acquisition or construction of buildings in designated Special Flood Hazard Areas” within participating communities (FEMA 2002).

Later, in 1994, the two acts were amended with the National Flood Insurance Reform Act, which included a requirement for FEMA to assess its flood hazard map inventory at least once every 5 years. FEMA prepares floodplain maps based on the best available science and technical information available. However, changes to the watershed or the availability of new information may cause the need for a map revision. When a revision is required, the applicable community works with FEMA to develop the map revision through a Letter of Map Amendment (LOMA) or a Letter of Map Revision (LOMR) (FEMA 2002).

In order for communities to participate in the NFIP they must adopt and enforce floodplain management criteria. The local counties in which dam removal would cause hydrologic effects, Klamath County in Oregon and Siskiyou County in California, participate in the NFIP (FEMA 2002).

3.6.2.2 Affected County Flood Codes and Ordinances

- Klamath County Code (Klamath County Land Development Code Article 59) (Klamath County)
- Siskiyou County Code (Article 54, Chapter 6) (Siskiyou County)
- Siskiyou County Code (Policy 27, Chapter 10) (Siskiyou County)

Klamath County, Oregon

Article 59 of the Klamath County Land Development Code includes the Flood Hazard Overlay in accordance with the NFIP. It includes provisions for development within and around designated flood hazard areas and defines those areas according to the Flood Insurance Rate Map prepared by FEMA. It also includes provisions for alterations of watercourses and waterway development that preclude any diminishment of the flood carrying capacity of a water course (Klamath County 2010a). The *Klamath County Comprehensive Plan* (2010b) establishes goals and policies for areas subject to natural disasters and hazards; this includes identifying flood prone areas on maps to protect life and property from natural disasters and hazards. The Comprehensive Plan specifies that "the County will continue to participate in the FEMA NFIP."

Siskiyou County, California

Siskiyou County has policies related to flood hazards within its County General Plan (1997). These policies refer to flood boundaries shown on FEMA flood hazard maps and regulate development within and near flood hazard areas (Siskiyou County 1997). Article 54 of the Siskiyou County Zoning Ordinance (Chapter 6) further defines the regulations within District F (Floodplain Combining Districts) where areas experience inundation by periodic overflow and backwater (Siskiyou County 1986). Chapter 10 of Planning and Zoning Code addresses Flood Damage Prevention and provides for requirements to notify the Federal Insurance Administration of alteration or relocation of watercourses and also addresses other issues related to Flood Damage Prevention. Land Use Policy 27 states the following:

> "No residential or industrial development shall be allowed on water bodies. Exceptions may be considered for water supply, hydroelectric power generation facilities, public works projects necessary to prevent or stabilize earth movement, erosion, and the enhancement of migratory fish and other wildlife, light commercial, open space, non-profit and non-organizational in nature recreational uses, and commercial/recreational uses." (Siskiyou County 1990)

3.6.3 Existing Conditions/Affected Environment

This section describes the hydrologic conditions of surface water and wetlands in the Klamath Basin. Figure 3.6-1 shows the area of analysis. The setting section includes a description of basin hydrology including precipitation, reservoirs, major rivers and tributaries; lakes; springs and seeps providing measurable flow; historic stream flows; and flood hydrology. Available data of existing average daily and monthly river flows and their relationship to Reclamation's Klamath Project and PacifiCorp's Klamath Hydroelectric Project are also described throughout this section.

3.6.3.1 Historical Hydrologic Conditions

Pre-Dams and Pre-Klamath Project Hydrology

Several studies have been conducted to determine the natural flow conditions of the Klamath Basin hydrology (Bureau of Reclamation [Reclamation] 2005); however, these studies are limited by a lack of data. Prior to development of dams and implementation of Reclamation's Klamath Project, the Upper Klamath Basin contained lakes and large areas of marshes and wetlands. The Upper Klamath Lake was not much larger than its current size; however, Tule Lake and Lower Klamath Lake were much larger. Springs, snowmelt, and groundwater dominated rivers carrying water from the Cascades and other highlands in the Upper Basin contributed greatly to Upper Klamath Lake, the Klamath River, and the wetlands and marshes in that area (Akins 1970). The elevation of Upper Klamath Lake was originally controlled by a natural rock reef dam at the outlet of the lake. Water then flowed 1.3 miles down the Link River to Keno Impoundment/Lake Ewauna. Within this stretch of river, Keno Impoundment/Lake Ewauna developed because of a natural rock reef dam near Keno, Oregon. This was and still is the beginning of the Klamath River.

During high flow events out of Upper Klamath Lake, some water was captured and would flow down the Lost River Slough and into Tule Lake, another natural sump and wetland area. Water that flowed into the Klamath River reached another split near Keno (Akins 1970).

During flood conditions, water would also back up from the Keno Reef (near Keno, Oregon) and flow into the Klamath Straits and down to Lower Klamath Lake. The Lower Klamath Lake and Tule Lake areas once contained large areas of wetlands and marshes. The Lost River flowed from Clear Lake to Tule Lake. Now, a diversion provides water from the Lost River to the Klamath River (Akins 1970). Figure 3.6-2 shows the historic wetlands and configuration of the Upper Basin.

The presence of both historic Tule and Lower Klamath Lake influenced flows in the Klamath River. Lower Klamath Lake (approximately 30,000 acres of open water and 55,000 surface acres of marsh) was connected to the Klamath River through the Klamath Straits. When the river began to rise in the spring during high water flow events, water overflowed into this lake and marsh and, as the river fell in the fall some of the water flowed back out of the lake (Weddell et al. Undated). Lower Klamath Lake provided some short term storage by reducing the total volume of water leaving the upper watershed as well as delaying the peak flow. Tule Lake received overflow during high flow periods from the Klamath River near Klamath Falls, Oregon. Tule Lake was a terminal lake system; the overflow through the Lost River Slough reduced peak flows in the Klamath River in late winter and spring (Abney 1964).

Below the Keno Reef, the Klamath River flowed freely with no dam controls. The J.C. Boyle, Copco and Iron Gate Reservoirs did not exist. Dams along major tributaries entering the river also did not exist and the water flowed to the river, then to the Klamath Estuary and eventually to the Pacific Ocean.

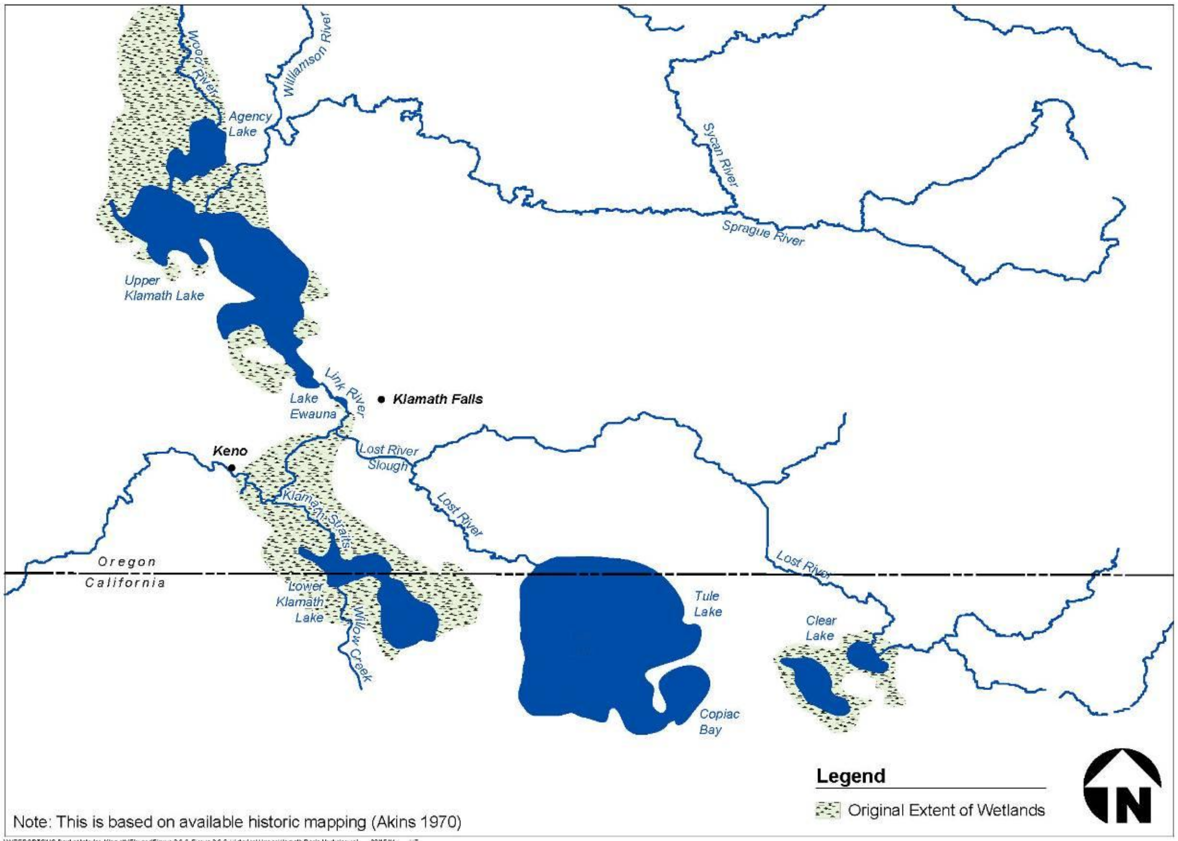


Figure 3.6-2. Historical Upper Klamath Basin Hydrology Before Dams, National Wildlife Refuges, and Reclamation's Klamath Project

Historical Uses Affecting River Flows

During the early part of the 19th century, the Klamath Basin was home to seven Indian Tribes (see Section 3.13, Cultural and Historic Resources). These tribes depended on the Klamath River to produce salmon, steelhead, and other fish, which contributed to their survival and culture. During this time period, the river system had no dams, and the wetland areas of the upper basin including Upper Klamath Lake, Tule Lake and Lower Klamath Lake had not been altered (FERC 2007).

When the U.S. Congress passed the Reclamation Act of 1902 and the Reclamation's Klamath Project was authorized in 1905, the first major hydrologic changes to the mainstem of the Klamath Basin occurred. The Reclamation Act supported development in the "arid West" by allowing the federal government to fund irrigation projects (Department of the Interior [DOI] 2011b), and settlers reclaimed wetlands for agricultural use during the period of 1917 to 1949 (FERC 2007). In 1905, the Oregon and California legislatures and the U.S. Congress passed the Cessation Act for all necessary legislation to begin Reclamation's Klamath Project (DOI 2011a). Afterwards, Reclamation began building its Klamath Project, which led to the construction of the Link River Dam, several hundreds of miles of irrigation ditches and large canals and pumping plants to divert water from the Klamath River watershed for agricultural use (FERC 2007).

In 1908, President Roosevelt created the Lower Klamath Lake National Wildlife Refuge (NWR). Later, in 1928, the Tule Lake and Upper Klamath Lake NWRs were also created, and a portion of the water from the Upper Klamath Lake was diverted to these NWRs (FERC 2007). Historic wetland areas were drained to accommodate agricultural development; however, some of the historic wetland areas around Upper Klamath Lake have more recently been returned to Upper Klamath Lake.

Development of hydroelectric plants in the Klamath Basin began as early as 1891 in the Shasta River canyon to provide electricity for the City of Yreka. In 1895, another facility was constructed on the east side of the Link River supplying power to Klamath Falls, Oregon. Additional power suppliers developed facilities in the area on Fall Creek and the West Side plant on the Link River (FERC 2007). Chapter 1 provides additional historical detail regarding the Klamath Hydroelectric Project.

Concern over the effects of these dams on salmon and suckers grew over the years. The shortnose and Lost River suckers were listed as endangered under the Endangered Species Act in 1988 (FERC 2007). The Southern Oregon/Northern California Coast coho salmon were reviewed in 1996 and listed as threatened in 1997. Oregon Coast coho salmon were listed in 1998. The listings were reaffirmed and uplisted to endangered in 2005 (National Oceanic and Atmospheric Administration [NOAA] Fisheries Service 2005). Section 3.3, Aquatic Resources, provides background information and an analysis of effects on these endangered species.

3.6.3.2 Basin Hydrology

This section describes reservoirs, rivers, and creeks in the affected environment and lists historic average stream flows. Various springs and seeps occur in the vicinity of Iron Gate, Copco and J.C. Boyle Dams and contribute flows to surface water. Springs around Upper Klamath Lake provide inflow to many of the streams feeding the lake and also provide stability for area wetlands (Akins 1970). Section 3.7.3.1, describes the locations of springs and seeps in more detail. Some measurable inflows from springs and seeps to various surface waters are described below. Figure 3.6-1 shows the major reservoirs and rivers in the Klamath Basin.

Precipitation

The Upper Klamath Basin receives rain at all elevations and snow at elevations above 4,000 feet during the late fall, winter, and spring. Snow is the primary form of precipitation in the upper watershed. Depending on the elevation and location, the amount of precipitation ranges from approximately 10 to more than 50 inches per year. From 1907 through 1997 the average annual precipitation at Klamath Falls was 13.4 inches and from 1959 to 2009 it was 20 inches at Copco 1 Dam (DOI 2011b). Peak stream flows generally occur during snowmelt runoff around March through May. After the runoff has stopped, flows drop to low levels in the late summer or early fall. Fall storms may increase flows compared with the lower summer flows. Generally, conditions in the Upper Klamath Lakes area are drier than the area where the Klamath River reaches the ocean. The reaches downstream of the Klamath River's confluence with the Shasta River receive higher levels of precipitation than other reaches in the Klamath Basin (FERC 2007). Average annual precipitation is 49 inches at Happy Camp from 1914 to 2010 and 80 inches at Klamath between 1948 and 2006 (Desert Research Institute Website 2011).

Upper Klamath Basin

Upper Klamath Lake and Link River Dam

Link River Dam was constructed by PacifiCorp for Reclamation in 1921 at the natural outlet of Upper Klamath Lake. This dam is operated by PacifiCorp under an agreement with Reclamation. Upper Klamath Lake has an active storage capacity ranging from 502,347 acre feet at the existing reservoir to 597,817 acre feet including areas restored by levee and dike breaches at Agency Lake, Barnes Ranch, Tulana Farms, and Goose Bay (Greimann 2011). Currently, Reclamation manages Upper Klamath Lake in accordance with United States Fish and Wildlife Service (USFWS) and NOAA Fisheries Service biological opinions based on current and expected hydrologic conditions (DOI 2011c).

Outlets from Upper Klamath Lake include the Reclamation A Canal, PacifiCorp's East and West Side development canals and the Link River Dam. Water that passes through the East and West Side development canals re-enters the Link River downstream of the dam where it eventually enters Keno Impoundment/Lake Ewauna (FERC 2007).

Reclamation's Klamath Project

Operation of Reclamation's Klamath Project affects Klamath River flows and Upper Klamath Lake water surface elevations. Section 3.8, Water Supply/Water Rights, describes the scope of Reclamation's Klamath Project in more detail, including the water supply diversions and amount of water diverted. Reclamation is required to implement a management plan to address biological opinions and fish concerns. To help accomplish this, Reclamation issues an annual operations plan describing flow requirements at various exceedance levels stated in biological opinions (Reclamation 2010). The biological opinions include requirements for targeted flows for Iron Gate Dam releases and water surface elevations in Upper Klamath Lake. Annual operations plans for Reclamation's Klamath Project must plan for flows and water surface elevations that are adequate for the continued existence of salmon and suckers. This is accomplished, in part, by using the fall and winter flow variability program "to enhance flow variability to mimic the natural hydrologic response that would naturally occur" (NOAA Fisheries Service 2010) and increased spring discharge in select average and wetter exceedances. Table 3.6-1 describes flow release requirements in cubic feet per second (cfs) from 2010 to 2018 measured below Iron Gate Dam under the biological opinion (NOAA Fisheries Service 2010). Each year, under the flow variability program, the hydrology exceedance is determined based on watershed modeling that considers "hydrologic and climatological information, including data from tributaries within the PacifiCorp Hydroelectric Project Reach (Keno Dam to Iron Gate Dam)." A team comprised of representatives from NOAA Fisheries Service (NMFS), NOAA Weather Service, USFWS, United States Geological

Survey (USGS), California Department of Fish and Game, the Karuk, Hoopa Valley and Yurok Tribes, PacifiCorp and Reclamation make this determination. Exceedance level calculations are affected by many factors including water use upstream of Upper Klamath Lake and Reclamation's Klamath Project demand when sufficient water supply is available (NOAA Fisheries Service 2010).

The "Exceedance Level" column represents hydrologic conditions ranging from very dry to very wet conditions. A 90 percent exceedance level represents a flow that is exceeded 90 percent of the time (dry conditions). A 10 percent exceedance level represents a flow that is exceeded only 10 percent of the time (wet conditions). Exceedance level calculations are affected by many factors including water use upstream of Upper Klamath Lake and Reclamation's Klamath Project demand when sufficient water supply is available (NOAA Fisheries Service 2010).

The flow requirements included in Table 3.6-1 describe the flow release requirements during the corresponding year type during the time periods indicated. As Table 3.6-1 shows, the flow release rate allowed under the biological opinion for releases from Iron Gate Dam in July of a very dry year (represented by a 90 percent exceedance) would be 840 cfs. Reclamation is required to release adequate flows from Upper Klamath Lake and regulate these flows at Keno Dam to allow PacifiCorp to meet these flow requirements at Iron Gate Dam.

Table 3.6-1. Biological Opinion Requirements for Iron Gate Dam Releases (cfs)

Exceedance Level	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug. 1-5	Aug. 16-31	Sept.
95%	1,000	1,300	1,260	1,130	1,300	1,275	1,325	1,175	1,025	805	880	1,000	1,000
90%	1,000	1,300	1,300	1,245	1,300	1,410	1,500	1,220	1,080	840	895	1,000	1,000
85%	1,000	1,300	1,300	1,300	1,300	1,450	1,500	1,415	1,160	905	910	1,001	1,000
80%	1,000	1,300	1,300	1,300	1,300	1,683	1,500	1,603	1,320	945	935	1,005	1,006
75%	1,000	1,300	1,300	1,300	1,300	2,050	1,500	1,668	1,455	1,016	975	1,008	1,013
70%	1,000	1,300	1,300	1,300	1,300	2,350	1,500	1,803	1,498	1,029	1,005	1,014	1,024
65%	1,000	1,300	1,300	1,300	1,323	2,629	1,589	1,876	1,520	1,035	1,017	1,017	1,030
60%	1,000	1,300	1,300	1,309	1,880	2,890	2,590	2,029	1,569	1,050	1,024	1,024	1,041
55%	1,000	1,300	1,345	1,656	2,473	3,150	2,723	2,115	1,594	1,056	1,028	1,028	1,048
50%	1,000	1,300	1,410	1,751	2,577	3,177	3,030	2,642	1,639	1,070	1,035	1,035	1,060
45%	1,000	1,300	1,733	2,018	2,728	3,466	3,245	2,815	1,669	1,077	1,038	1,038	1,066
40%	1,000	1,300	1,837	2,242	3,105	3,685	3,485	2,960	1,682	1,082	1,041	1,041	1,071
35%	1,000	1,300	2,079	2,549	3,505	3,767	3,705	3,115	1,699	1,100	1,050	1,050	1,085
30%	1,000	1,434	2,471	2,578	3,632	3,940	3,930	3,225	1,743	1,118	1,053	1,053	1,089
25%	1,000	1,590	2,908	2,627	3,822	3,990	4,065	3,390	2,727	1,137	1,058	1,058	1,097
20%	1,000	1,831	2,997	2,908	3,960	4,160	4,230	3,480	2,850	1,152	1,066	1,066	1,135
15%	1,000	2,040	3,078	3,498	4,210	4,285	4,425	3,615	2,975	1,223	1,093	1,093	1,162
10%	1,000	2,415	3,280	3,835	4,285	4,355	4,585	3,710	3,055	1,370	1,126	1,126	1,246
5%	1,000	2,460	3,385	3,990	4,475	4,460	4,790	3,845	3,185	1,430	1,147	1,147	1,281

Source: NOAA Fisheries Service 2010
Notes:
cfs: cubic feet per second

Keno Impoundment/Lake Ewauna and Keno Reach

Keno Impoundment/Lake Ewauna existed before the construction of Keno Dam due to a natural blockage (Akins 1970). The Keno Dam is owned and operated by PacifiCorp. Before the dam, in 1908, water from the Keno Impoundment/Lake Ewauna was reported to overflow the natural blockage and enter the Lost River Slough when the water surface elevation was at approximately 4,085 feet (FERC 2007). The currently normal water surface elevation is 4,085 feet (USGS 2009a) at the Keno Impoundment/Lake Ewauna. The Keno Impoundment/Lake Ewauna is a long and narrow lake that begins where the Link River ends, 1.3 miles downstream of the Link River Dam, and ends at Keno Dam. The majority of the water entering Keno Impoundment/Lake Ewauna comes from Upper Klamath Lake through the Link River. Several facilities upstream of Keno Dam transport water to or from the river including: the Lost River Diversion Channel, North Canal, Klamath Straits Drain, and the Ady Canal. Additional facilities that divert water for private agricultural lands are also on the reach between Keno Dam and J.C. Boyle Reservoir (FERC 2007).

J.C. Boyle Reservoir

J.C. Boyle Reservoir is approximately 5 miles downstream of Keno Dam. PacifiCorp operates J.C. Boyle Reservoir to produce hydroelectric power. Current operations of the reservoir follow Interim Measures from the Interim Conservation Plan effective as of February 2010. Water is spilled from the dam during high flow months of January through May and when inflow "exceeds the capacity of the J.C. Boyle powerhouse and low flow requirements" (FERC 2007).

J.C. Boyle Bypass Reach

The J.C. Boyle Bypass Reach is a 4.3-mile section of the Klamath River between the J.C. Boyle Dam and Powerhouse; it flows at a steep grade. At 0.5 miles downstream of the dam, flows are increased by groundwater entering the bypass reach. The average accretion due to groundwater inflow/spring inflow is 220 to 250 cfs and varies seasonally and from year to year (FERC 2007).

J.C. Boyle Peaking Reach

The J.C. Boyle Peaking Reach is downstream of the J.C. Boyle powerplant, so flows vary based on releases from the plant. Typically, the reach has high flows during the day as a result of powerhouse flows used to provide peak energy demand. The powerhouse flows may be reduced to zero at night when J.C. Boyle Reservoir is refilled. The powerhouse ramps up flow for either a one-unit operation (up to 1,500 cfs) or a two-unit operation (up to 3,000 cfs). Normal daily average flows in the peaking reach during periods with no power generation range from 320 to 350 cfs (80 cfs from the fish ladder, 20 cfs from the juvenile fish bypass system). A minimum monthly flow rate of 302 cfs has been recorded in the month of August based on data from 1959 to 2010 (USGS 2011). Additional water enters the reach from springs.

Commercial whitewater rafting and boating occurs during the same months as peak power demands, May through October. The water supply for this unique rafting opportunity during the summer tourist season is from the peaking operations of J.C. Boyle powerhouse. Under PacifiCorp's current annual FERC license, upramping and downramping occur at a rate of 9 inches per hour for both (FERC 2007). PacifiCorp diverts some water from this reach for irrigation purposes (FERC 2007).

Copco 1 Reservoir

PacifiCorp operates Copco 1 Reservoir for hydroelectric power generation through Copco 1 Dam. With the most active storage volume of all the project reservoirs of 6,235 acre feet for power production, Copco 1 Reservoir has a total storage capacity of 46,867 acre feet (DOI 2011c). This reservoir is deeper than both Keno Impoundment/Lake Ewauna and J.C. Boyle Reservoir (FERC 2007).

Copco 2 Reservoir and Bypass Reach

Copco 2 Reservoir, a small impoundment, receives discharge from Copco 1 Reservoir through Copco 1 Dam and provides flow to Copco 2 Powerhouse through a 1.5-mile bypass reach. The maximum hydraulic capacity is 3,200 cfs in the powerhouse flowline controlling flows from Copco 1 Reservoir to Copco 2 Reservoir. Copco 2 Dam controls the flow from the reservoir, and only spills when inflow from the reservoir exceeds storage capacity. Spillage from the dam is rare and typically only happens from November through April. PacifiCorp releases between 5 to 10 cfs at the bypass reach under normal conditions. Copco 2 Powerhouse discharges water to Iron Gate Reservoir (FERC 2007).

Iron Gate Reservoir

Iron Gate Reservoir is downstream from the Copco 2 Dam and also receives water from Jenny and Fall Creeks, which are tributaries to the Klamath River downstream of Copco 2 Dam and Iron Gate Reservoir. PacifiCorp operates Iron Gate Dam and Reservoir as a re-regulating facility for peaking operations at the other three hydroelectric power dams. Iron Gate Reservoir is the deepest of the four reservoirs in the Hydroelectric Reach. The total storage at this reservoir is approximately 58,794 acre feet of which 3,790 acre feet is available for power production (DOI 2011c). Iron Gate Powerhouse, at the base of the dam, has a maximum hydraulic capacity of 1,735 cfs. Cool water is diverted from the reservoir to the Iron Gate Fish Hatchery, downstream of the dam (FERC 2007). USGS gage station 11516530 on the Klamath River, downstream of Iron Gate Dam, provides flow monitoring data regarding compliance with NOAA Fisheries Service biological opinions. Bogus Creek and effluent from the hatchery enter the river upstream of the gage and downstream of the dam (USGS 2009b). Table 3.6-1 lists the flow requirements measured downstream of Iron Gate Dam.

Lower River Basin

The Lower Klamath Basin includes the river area downstream from Iron Gate Dam, which includes 190 miles of river flowing to the Klamath Estuary and then to the Pacific Ocean. The major tributaries entering the river include the Shasta, Scott, Salmon and Trinity Rivers. The Klamath Basin is heavily influenced by these four rivers because 44 percent of the average annual runoff is provided by them (FERC 2007). Below are brief descriptions of these four rivers and other reaches along the Lower Klamath River.

Shasta River

The Klamath River receives water from the Shasta River approximately 13.5 miles downstream of Iron Gate Dam. The watershed includes high mountain peaks, forested terrain and agricultural land. Peak flows, near the Shasta River's confluence with the Klamath River, are in the winter with minimum flows during July and August. Dwinnel Dam, approximately 25 miles upstream of its confluence with the Klamath River, resulted in the creation of Lake Shastina. Additional diversion dams and smaller dams are located between Dwinnel Dam and the Klamath River (FERC 2007).

Scott River

The Klamath River receives water from the Scott River approximately 33.6 miles downstream of the Klamath River's confluence with the Shasta River. The watershed includes the Salmon Mountains, which are heavily forested creating a rain shadow for the rest of the watershed. The valley is comprised of land for grazing and agriculture. Average monthly flows entering the Klamath River from the Scott River are 4 to 5 times higher in the winter and spring months than from the Shasta River; however, minimum flows are similar during August and September (FERC 2007).

Klamath River at Seiad Valley

A USGS flow gage is on the Klamath River at Seiad Valley, downstream of its confluence with the Scott River. During the low flow months of August through November, approximately 75 percent of the water flowing past this gage is attributed to Iron Gate Dam releases. During the high flow months of April through June approximately 50 percent of the water flowing past this gage is attributable to Iron Gate Dam releases (FERC 2007).

Salmon River

Approximately 77 miles from the Klamath River's confluence with the Scott River, the Salmon River enters the Klamath River. The Salmon River flows through the Klamath National Forest and many designated wilderness areas. The region surrounding the Salmon River is forested with some agricultural activity. High monthly average flows (3,375 cfs) occur in January, which is the winter peak for flooding as rain and rain on snow events occur. In April and May, the Salmon River has a high monthly average flow (2,660 and 2,630 cfs, respectively) from snowmelt at higher elevations. The Salmon River has its lowest monthly average flow at about 200 cfs in September, which is later than for other tributaries upstream including the Shasta River where lowest monthly average flow occurs in July (FERC 2007).

Klamath River at Orleans

USGS gage no. 11523000 is at Orleans, downstream of the Klamath's confluence with the Salmon River and other smaller tributaries within the Lower Klamath watershed. This area receives a high amount of precipitation compared to other reaches upstream of the Shasta River; therefore, higher flows than in upstream reaches occur here in the winter and spring months. Iron Gate Dam releases account for approximately 20 percent of the flow during these high flow periods and over 50 percent of the flow during the late summer and fall (FERC 2007).

Trinity River

The Trinity River is the largest tributary to the Klamath River and is downstream of the Klamath River's confluence with the Salmon River and Orleans. It is heavily forested and receives a heavy amount of precipitation. Peak average monthly flows into the Klamath River occur in February and March at approximately 11,000 cfs and flows decrease to a low of 500 cfs in September (FERC 2007).

Klamath River at Klamath

A USGS gage no. 11530500 is at the mouth of the Klamath River where it meets the estuary within the Lower Klamath watershed. During low flow periods, the releases from Iron Gate Dam account for approximately 40 percent of flow during September to October. However, the area surrounding the Klamath River reach downstream of its confluence with the Trinity River receives a heavy amount of precipitation, and during the winter months approximately 85 percent of the flow comes from other sources than Iron Gate Dam releases (FERC 2007).

Klamath River Estuary

The Klamath River estuary is within the Redwood National Park and spans approximately 4 to 5 miles upstream of the mouth. The tidal influence normally extends approximately 4 miles upstream from the mouth during high tides greater than 6 feet upstream of the U.S. Highway 101 bridge. Past studies have observed the formation of a sill at the river mouth in late summer or early fall causing a standing water backup up to 6 miles upstream. During high tides saltwater was observed in the summer and early fall from the mouth upstream ranging approximately 2.5 to 4 miles depending on the time period samples were taken. The saltwater recedes during low tides (Wallace 1998).

3.6.3.3 Historic Stream Flows

The USGS operates several stream gages on the Klamath River (Table 3.6-2 and Figure 3.6-3). As noted above, summer and early fall periods (July through October) generally have much lower flows than the months of the spring runoff. Tributaries downstream of Iron Gate Dam contribute substantial amounts of flow. Figure 3.6-4 shows historical daily average stream flows at several locations on the river using USGS monitoring data from 1961-2009 (USGS 2011). Flows are substantially higher during wet years; Table 3.6-3 shows historic average monthly flows during wetter years (represented by flows exceeded ten percent of the time) using the same USGS data (USGS 2011).

Table 3.6-2. USGS Gages on the Klamath River

USGS Gaging Station	Station Name	Drainage Area (miles^2)	Latitude	Longitude	Gage Elevation (feet)	Period of Record (Water Years)
11509500	Klamath River at Keno, OR	3,920	42°08'00"	121°57'40"	3,961	1905-1913 1930-2009
11510700	Klamath River below John C. Boyle Power Plant near Keno, OR	4,080	42°05'05"	122°04'20"	3,275	1959-2009
11512500	Klamath River below Fall Creek near Copco, CA	4,370	41°58'20"	122°22'05"	2,310	1924-1961
11516530	Klamath River below Iron Gate Dam, CA	4,630	41°55'41"	122°26'35"	2,162	1961-2009
11520500	Klamath River near Seiad Valley, CA	6,940	41°51'14"	123°13'52"	1,320	1913-1925 1952-2009
11523000	Klamath River at Orleans, CA	8,475	41°18'13"	123°32'00"	356	1927-2009
11530500	Klamath River near Klamath, CA	12,100	41°30'40"	123°58'42"	5.6	1911-1927 1932-1994, 1996, 1998-2009

Source: DOI 2011c

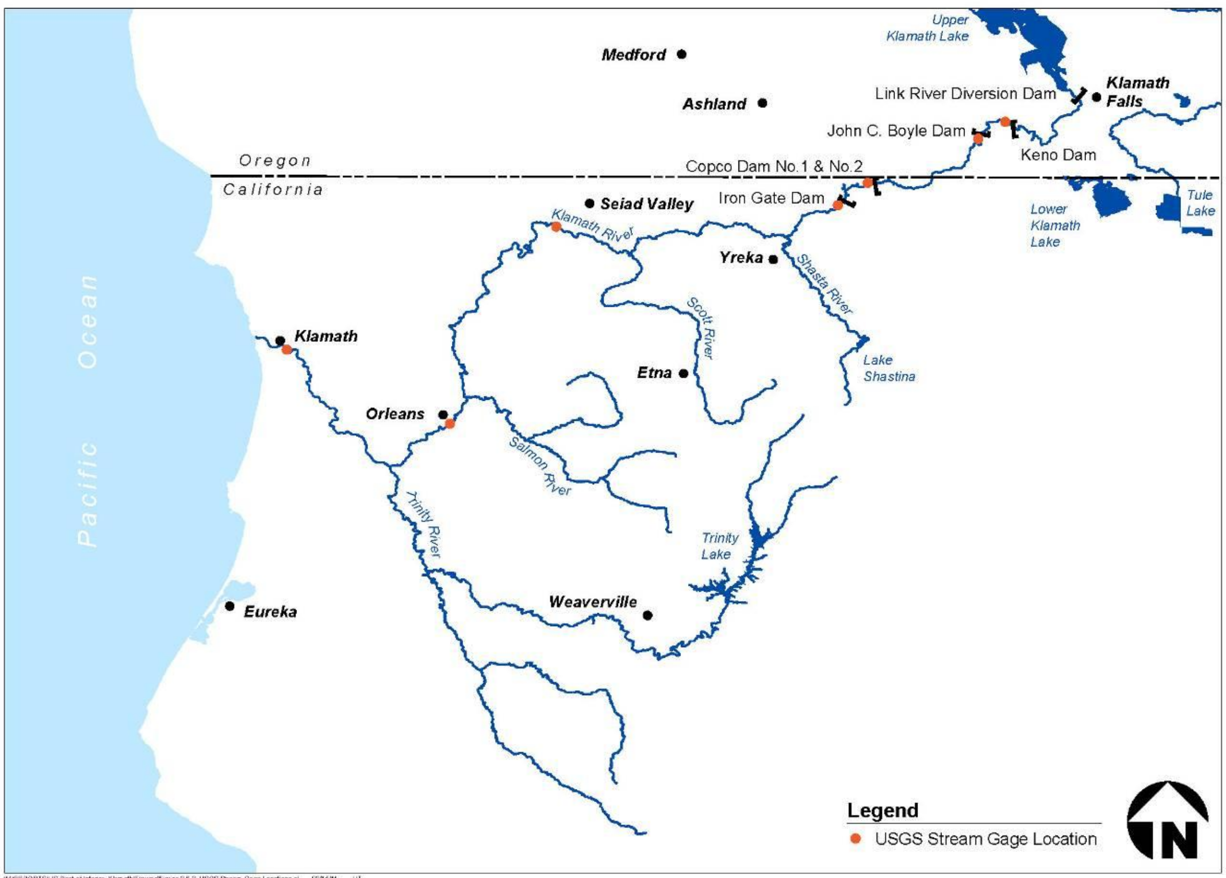
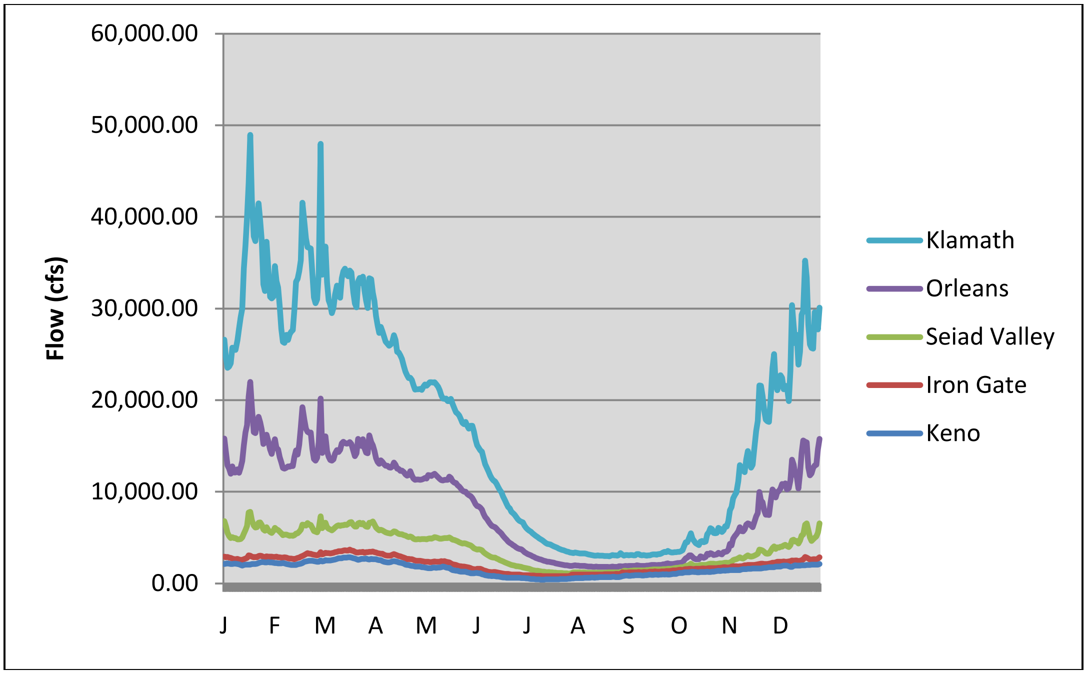


Figure 3.6-3. USGS Stream Gage Locations



Source: USGS 2011

Figure 3.6-4. Daily Average Flows at Five USGS Stream Gages on Klamath River

Table 3.6-3. Historic Monthly Average Flows (cfs) in Wetter Years (10% Exceedance Level) during Water Years 1961-2009 on the Klamath River

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.
Keno Dam	2053	2625	3304	3645	4703	5691	4543	3046	1525	755	788	1225
J.C. Boyle Dam	2271	2824	3449	3720	4727	5741	4766	3346	1823	1010	1035	1441
Iron Gate Dam	2447	3047	3994	4544	5567	6429	5487	3918	2003	1059	1094	1582
Seiad Valley	3070	4606	9372	11866	11129	11658	9516	8077	5262	1985	1461	1903
Orleans	4031	11635	28185	33198	23710	25697	20345	18408	11277	4060	2343	2418

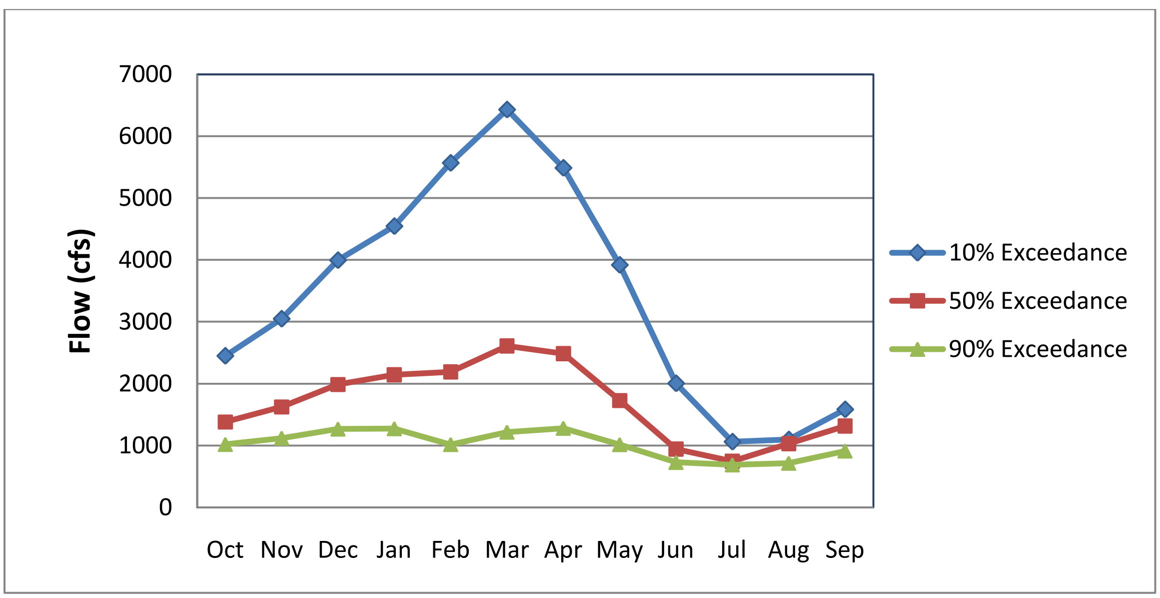
Source: USGS 2011

Table 3.6-4 shows the daily average flows at the four dams. The column indicating "% of time equaled or exceeded" indicates the hydrologic conditions, with 99 percent being an extremely dry year and 1 percent being an extremely wet year. Figures 3.6-5 and 3.6-6 show average daily flows in different year types downstream from Iron Gate and J.C. Boyle Dams. The gage downstream of J.C. Boyle Dam is also downstream of the return of flow from the J.C. Boyle power plant.

Table 3.6-4. Annual and Seasonal Daily Flows

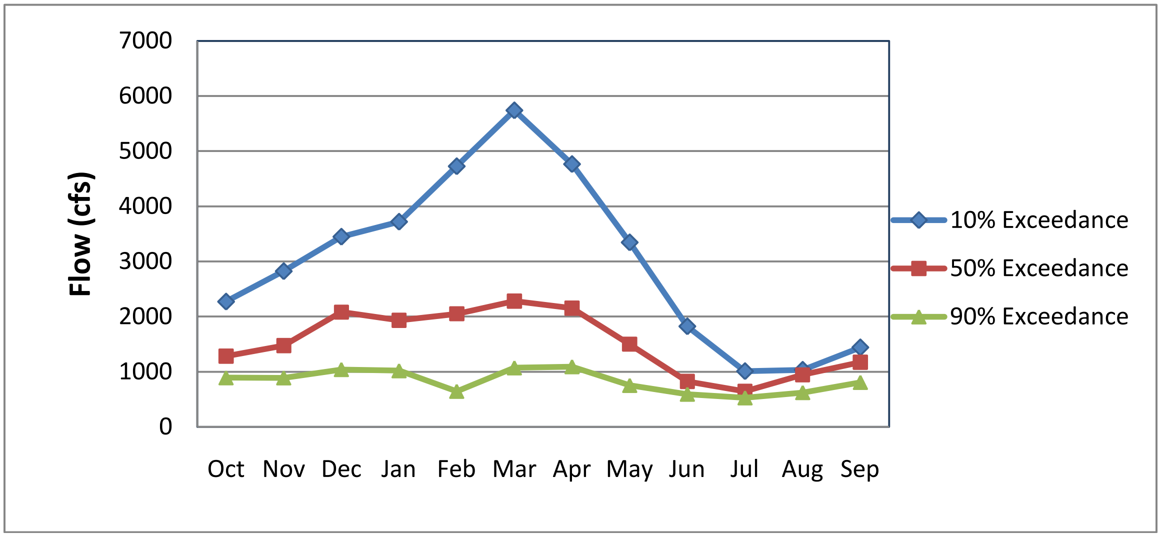
% of time equaled or exceeded	Discharge (cfs)							
	Annual				Seasonal (July 1 – Nov 31)			
	Keno	Boyle	Copco	Iron Gate	Keno	Boyle	Copco	Iron Gate
99	152	331	290	528	147	325	294	441
95	297	522	529	716	292	473	524	701
90	431	635	643	741	417	592	604	725
80	645	802	882	955	621	725	823	846
70	821	962	1,088	1,040	737	856	973	1,000
60	990	1,130	1,269	1,320	901	960	1,150	1,030
50	1,180	1,260	1,483	1,360	1,020	1,060	1,273	1,130
40	1,440	1,480	1,730	1,700	1,180	1,180	1,470	1,320
30	1,800	1,810	2,104	1,977	1,390	1,280	1,670	1,350
20	2,390	2,660	2,640	2,980	1,580	1,490	1,905	1,510
10	3,120	3,200	3,350	3,870	1,960	1,890	2,300	1,840
5	4,320	4,530	4,486	5,500	2,450	2,710	2,720	2,920
1	6,875	7,660	7,295	9,167	3,300	3,970	3,536	4,350

Source: DOI 2011c



Source: USGS 2011

Figure 3.6-5. Stream Flows Downstream from Iron Gate Dam in Wet, Average, and Dry Years



Source: USGS 2011

Figure 3.6-6. Stream Flows Downstream from J.C. Boyle Dam in Wet, Average, and Dry Years

Table 3.6-5 shows the flows associated with different flood levels in the basin. Peak flows at Iron Gate Dam are substantially greater than peak flows at J.C. Boyle Dam, because of the tributaries that enter the Klamath River in the Hydroelectric Reach, and peak flows continue to increase substantially as tributaries enter the Klamath River. The 10-yr discharge at Seiad Valley, which is downstream of the Scott River, is 56,500 cfs. The 10-yr discharge at the mouth is close to 300,000 cfs.

Table 3.6-5. Flood Frequency Analysis on Klamath River for 10-yr to 100-yr Floods based upon Full Period of Record[1] of Each Gage

Gaging Station	Drainage Area (miles^2)	Discharge (cfs)				
		Gage Base	10-yr	25-yr	50-yr	100-yr
Keno	3,920	4,000	8,642	10,350	11,200	11,800
Boyle	4,080	4,000	9,058	11,050	12,220	13,150
Copco	4,370	5,400	10,750	12,720	13,730	14,470
Iron Gate	4,630	N/A	15,610	21,460	26,280	31,460
Seiad	6,940	N/A	56,540	93,400	131,000	179,300
Orleans	8,470	N/A	163,100	230,300	287,000	348,900
Klamath	12,100	N/A	298,300	392,900	466,900	543,300

Source: DOI 2011c

Notes:

[1] Keno Dam 1905-1913, 1930-2009; J.C. Boyle Dam 1961-2009; Copco 1 Dam 1930-1961; Iron Gate Dam 1961-2009. Data for all gages except Iron Gate Dam was extended using equations to match the period of record for Keno Dam.

Key:

cfs: cubic feet per second

3.6.3.4 Flood Hydrology and River Flood Plain

The active storage capacity at Upper Klamath Lake is approximately 597,817 acre-feet and includes areas restored by levee and dike breaches at Agency Lake, Barnes Ranch, Tulana Farms, and Goose Bay (Greimann 2011). Active storage at Keno, J.C. Boyle, Copco 1, Copco 2 and Iron Gate reservoirs totals approximately 12,244 acre-feet (FERC 2007). Approximately 98 percent of the active surface water storage along the Klamath River is provided by Upper Klamath Lake behind Link River Dam. Keno, J.C. Boyle, Copco 1, Copco 2 and Iron Gate Dams provide approximately 2 percent of the active storage on the river.

During extremely wet years, increased flows occur in the Klamath River and its tributaries, and surface water elevations rise in Upper Klamath Lake. Agency Lake, Barnes Ranch, and the Nature Conservancy-owned lands provide over 108,000 acre feet of storage area due to breaching of dikes and levees. During these periods, there is little surplus storage at the four dams to help control flooding. Decreased irrigation demands may allow for more water in Upper Klamath Lake to be stored for future use depending on the decisions to balance spring flushing flows with fall migration flows. The biological opinions included provisions for average and wet years that increase minimum flow requirements at Iron Gate Dam and surface water elevations at Upper Klamath Lake and Agency Lake/Barnes Ranch to reflect the natural flow conditions during wetter years and provide storage for surplus water. The Klamath River overtops its banks during flood years and inundates the floodplain. Additional descriptions of area geomorphology are in Section 3.11, Geology, Soils and Geologic Hazards.

FEMA has prepared flood risk mapping for portions of the Klamath River in Siskiyou, Del Norte and Humboldt Counties and provides access to these maps via their web mapping service or can be downloaded from their website. The revised Flood Insurance Rate Map (FIRM) and Flood Insurance Study for Siskiyou County was released on January 19, 2011, however, this update did not include new flood analysis along the Klamath River. FEMA flood analysis for the river is based on studies and cross sections developed prior to 1985 and later revised in 1987.

3.6.3.5 Risks of Dam Failure

Dams are manmade structures and do exhibit some risks of failure that could result in flooding downstream. According to the Association of State Dam Safety Officials (ASDSO), dams fail due to one of five reasons (ASDSO 2011).

- Overtopping caused by water spilling over the top of dam;
- Structure failure of materials used in dam construction;
- Cracking caused by movements like the natural settling of dam;
- Inadequate maintenance and upkeep; or
- Piping – when seepage through a dam is not properly filtered and soil particles continue to progress and form sink holes in the dam.

In California, weighted point systems are used during inspections to classify both the hazard or damage potential and condition of the dam. Once classified, the frequency of inspection and return period for hydrology studies is selected. The classifications used for damage potential are extreme, high, moderate and low and refer to the possibility of loss of life and property downstream of the dam if it were to fail. The classifications of the condition of the dam are poor, fair, good, and excellent and are determined based on the age, general condition, geologic and seismic setting. Dams may be reclassified after improvements or other changes have occurred (ASDSO 2000).

Siskiyou County is in the process of developing a Multi-Jurisdictional Hazard Mitigation Plan which will address, among other issues, flood and dam failure hazards. Maps are currently available which describe dam inundation areas at J.C. Boyle and Iron Gate dams as well as a domino effect, depicting the inundation area if multiple dams were to fail at the same time (Siskiyou County Website 2011). The FERC staff have conducted safety inspections of the dam structures as part of the licensing program over the past 50 years. Every five years J.C. Boyle, Copco 1 and Iron Gate dams are inspected and evaluated by an independent consultant and reports documenting the evaluation are submitted to the FERC for review (FERC 2007).

3.6.4 Environmental Consequences

The flood hydrology section of the EIS/EIR will discuss the changes to river flows that would occur during implementation of the alternatives, including the Proposed Action.

3.6.4.1 Environmental Effects Determination Methods

The No Action/No Project Alternative would include operations similar to current operations. PacifiCorp would operate the Klamath Hydroelectric Project as it did before the Secretarial Determination process began, under the operational requirements of the March 2010 biological opinion. The action alternatives would vary operations by removing facilities or installing fish ladders to provide fish passage.

The assessment of the environmental impacts on flood hydrology that would result from implementation of the alternatives determines whether changes in stream flows could cause flooding or inundation areas in the watershed. The impact assessment is based on the hydrologic modeling completed by the Lead Agencies. The modeling covered the No Action/No Project Alternative and the Proposed Action. The Lead Agencies used a one-dimensional HEC-RAS model that assessed hydrologic conditions for these two alternatives. The Lead Agencies also analyzed modeling output to determine how frequently the current FEMA floodplain is inundated and how the floodplain could change under the Proposed Action. This information was included within the *Draft Hydrology, Hydraulics and Sediment Transport Studies for the Secretary's Determination on Klamath River Dam Removal and Basin Restoration* (DOI 2011c). The model results under the No Action/No Project Alternative and the Proposed Action provide adequate information to estimate the relative effects of the other alternatives not modeled.

The model results included predictions of the river flows that would occur if the Four Facilities were removed. The river flows would be the same for long-term future conditions for the Partial Facilities Removal of Four Dams Alternative as those modeled for the Proposed Action. The Fish Passage at Four Dams Alternative, however, would leave the dams in, but would include fish passage at each facility. Flows downstream of Iron Gate Dam would be the same under the Fish Passage at Four Dams Alternative as the No Action/No Project Alternative; however, flows within the hydroelectric reach would change to account for flows through fish ladders and flows in the bypass reaches. The predicted flows under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to the No Action/No Project Alternative at the two remaining dams and less than modeled flows under the Proposed Action at the removed dams. The flows within the hydroelectric reach for the Fish Passage at Four Dams and the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Dam alternatives are addressed qualitatively because the model does not simulate these flows. The modeling effort provided useful information for assessing the impacts on flood hydrology in the long-term, but provides limited information about the construction period. Flood risks associated with dam removal activities are described qualitatively and quantitatively using the SRH-1D modeling results completed by DOI, and the analysis includes the measures incorporated to reduce these risks.

3.6.4.2 Significance Criteria

For the purposes of this EIS/EIR, impacts would be significant if they would substantially increase the risks of exposing people or structures to loss, injury or death involving flooding as measured by changes in the FEMA 100-year floodplain.

3.6.4.3 Effects Determinations

Alternative 1: No Action/No Project

The No Action/No Project Alternative could alter river flows and result in changes to flood risks. Under the No Action/No Project Alternative (a Negative Determination), the Four Facilities would remain in place and operations similar to the current operations would be in effect. The PacifiCorp Klamath Hydroelectric Project and Reclamation's Klamath Project would be operated as they were before the Secretarial Determination process began, including operation requirements under the March 2010 biological opinion. PacifiCorp would operate indefinitely under annual FERC licenses. For the purpose of this EIS/EIR, however, the No Action/No Project Alternative includes operations that would be similar to current operations.

Table 3.6-6 shows modeled average monthly wet year flows at multiple points along the river under the No Action/No Project Alternative. Wet year flows are represented by the modeled 10 percent exceedance (flows are exceeded only ten percent of the time). The No Action/No Project Alternative flows are based on model results and the affected environment flows (Table 3.6-3) are based on historic monitoring data. The monthly flows described in the two tables (Tables 3.6-6 and 3.6-3) vary because the sources used to develop the data are different, but the flows are generally similar. Peak flows would likely exceed the average monthly flows in Table 3.6-6; however, the peak flows would be similar to those currently experienced because the No Action/No Project Alternative would not change operations.

Table 3.6-6. Modeled Average Monthly Flows (cfs) in Wetter Years (10% Exceedance Level) on the Klamath River under the No Action/No Project Alternative

	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.
Keno Dam	1022	1925	2867	3113	3859	4979	4752	3003	2493	894	794	901
J.C. Boyle Dam	1249	2159	3054	3396	4099	5265	5102	3482	2948	1178	1033	1113
Iron Gate Dam	1372	2351	3383	3939	5150	6145	5835	3910	3184	1344	1149	1207
Seiad Valley	1822	3898	7747	9511	10523	10987	9911	8486	6435	2388	1534	1482
Orleans	3283	10977	26536	29451	22477	26116	19837	18272	13067	4540	2415	2115

In addition to the model results described above, the Lead Agencies also modeled flood events that meet criteria for a 100-year flood using daily average flows under the No Action/No Project Alternative condition and the Proposed Action (Appendix J). The "WithDams_100yr" shown on the maps in Appendix J depicts the No Action/No Project Alternative condition (DOI Undated). All of the areas depicted on this map are within Siskiyou County. The FEMA 100-year flood area corresponds fairly closely with the Lead Agencies' modeling of flood risks both with and without dams which reinforces the fact that the four dams were not constructed for the purpose of flood risk reduction. However, there are some differences between the FEMA and the Lead Agencies' No Action/No Project Alternative 100-year inundation zones. These differences are attributable to the use of different hydrographic base data for flood events and the use of enhanced elevation data by the Lead Agencies. The Lead Agencies' analysis is based on LiDAR data with elevation values sufficient to support 2 foot contours along the reach of the Klamath River from Iron Gate to Happy Camp.

Detailed imagery was used to identify structures within the modeled No Acton/No Project Alternative 100-year inundation zone. Structures include mobile homes, houses, farm sheds, bridges, and other features large enough to cast a shadow, including hay stacks. Imagery from 2010 and 2009 was used and compared which revealed that many of the structures are mobile homes that move annually or seasonally. Within the FEMA 100-year floodplain, there are 481 structures that include bridges. The Lead Agencies' modeling of the 100-year flood inundation area under the No Action/No Project Alternative revealed 671 structures to be at risk.

The No Action/No Project Alternative includes operations that are the same as the existing operations; therefore, the No Action/No Project would not cause any changes to flooding from the affected environment. Although the Lead Agencies' mapping of the 100-year inundation area varies compared to FEMA mapping, this difference can be attributed to the use of different base data and the Lead Agencies' use of enhanced elevation data. FEMA is in the process of updating FIRMs using enhanced elevation data, but has not accomplished this near the Klamath River. Under the No Action/No Project

Alternative, the Four Facilities would not be removed and the actual 100-year flood inundation area would not change. The risks of dam failure would be same under the No Action/No Project alternative as under the existing conditions. **There would be no change from existing conditions from flood risk.**

Ongoing restoration actions could affect flood hydrology. Under the No Action/No Project Alternative, some restoration actions in the Klamath Basin are currently underway and would be implemented regardless of the Secretarial Determination on the removal of the Four Facilities. Table 3.6-7 lists the restoration actions affecting flood hydrology that would occur under the No Action/No Project Alternative. Several of these projects involve breaching levees and dikes upstream and around Upper Klamath Lake, thereby re-establishing hydrologic connections and providing additional storage that could potentially absorb some flood-related increases in inflows. The hydrologic model used to determine effects to flood hydrology under the No Action/No Project Alternative considered the expanded storage capacity described in Table 3.6-7 specifically related to evaporation and changes to consumptive use (DOI 2011c). **Overall, the ongoing restoration actions would cause no change from existing conditions from flood hydrology related to the affected environment.**

Table 3.6-7. No Action/No Project Alternative Resource Management Actions Affecting Flood Hydrology on the Klamath River

Component	Implemented Actions	Effects on Flood Hydrology
Williamson River Delta project	Restore wetlands for endangered fish and improve water quality in Upper Klamath Lake. The project involved breaching levees where the river flows into Upper Klamath Lake. Two miles of levees were breached in 2007 restoring approximately 3,500 acres of wetlands. Another 1,400 acres were flooded in 2008. Project would provide 28,800 AF of additional storage in Upper Klamath Lake. No additional levee breaching is proposed under this project	No impact, measures have already been implemented and are described as an existing condition.
Agency Lake and Barnes Ranches	Project to use the diked and drained portions of the ranches as interim pumped storage and ultimately to reconnect to Agency Lake by breaching dikes to add 63,770 AF of additional storage to Upper Klamath Lake. Actions include 1) complete land transfer between Reclamation and USFWS, 2) USFWS to study options to enhance water management flexibility for water storage and fish and wildlife habitat, and 3) complete NEPA analysis and ESA consultation on preferred option. Agency Lake Ranch and Barnes Ranch together comprise approximately 9,796 acres between Agency Lake and the Upper Klamath NWR. Options for water management could include using diked areas for pumped storage or breaching levees to reconnect former wetland areas to Agency Lake. Specific options to be developed and studied under separate NEPA evaluation.	Beneficial effect because more incidental flood protection could be provided.

Key:
AF: acre feet
ESA: Endangered Species Act
NEPA: National Environmental Policy Act
NWR: National Wildlife Refuge
USFWS: United States Fish and Wildlife Service

Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

Drawdown of reservoirs could result in short-term increases in downstream surface water flows and result in changes to flood risks. Reservoir drawdown activities would begin on November 1, 2019 at Copco 1 Dam, and on January 1, 2020 at J.C. Boyle and Iron Gate Dams, at which times hydroelectric power generation would cease. At Copco 2 Dam, reservoir drawdown activities would begin on June 1, 2020 to allow for continued hydroelectric power generation at this site until dam removal must begin. Releases at all of the dams during reservoir drawdown periods would be in accordance with Dam Removal Plans developed by the Lead Agencies and with applicable biological opinions and operation plans. The Dam Removal Entity (DRE) would control the releases that would vary by reservoir depending on the type of dam, discharge capacity, water year type, and the volume of water and sediment within the reservoir. The resultant reservoir water surface elevation after the initial drawdown would be generally higher in a wetter year than in a drier year at all the dams.

The reservoir drawdown plans were made with consideration for minimizing flood risks downstream. The DRE would carefully control drawdown to maintain flows that would not cause flood risks. Drawing down the reservoirs would increase storage availability in J.C. Boyle, Copco 1, and Iron Gate Reservoirs. If a flood event occurred during drawdown, the DRE would retain flood flows using the newly available storage capacity and continue drawdown after flood risks have ended. Existing conditions do not allow these reservoirs to assist in flood prevention in this manner.

At J.C. Boyle Dam, the DRE would begin reservoir drawdown activities in January while streamflows were still high. Controlled releases would initially be through the gated spillway and power penstock at normal release rates, depending on year type, plus additional flow of up to 100 cfs for reservoir drawdown. These releases would continue until the reservoir water surface elevation decreased to the lowest level possible for the streamflow occurring at that time. The DRE would then remove the stoplogs from one of two low-level culverts beneath the spillway, temporarily releasing additional water downstream at flows between approximately 1,900 and 2,700 cfs depending upon reservoir level. Penstock releases could be reduced if necessary to limit the total sudden increase in streamflow to between approximately 500 and 1,000 cfs. Once the reservoir water surface is stabilized at a lower level, the DRE would remove the stoplogs from the second low-level culvert, temporarily releasing additional water downstream at flows between approximately 1,000 and 1,900 cfs than the current flows at the time. After this, the reservoir would reach the lowest water surface elevation possible prior to removal of the dam embankment.

While the controlled releases during reservoir drawdown would be higher than simulated No Action/No Project Alternative releases during the same time period, they would not be likely to increase flood risks because they would be within the range of historic flows. A 10-year storm at J.C. Boyle results in an estimated flow of 9,058 cfs (see Table 3.6-5), and the maximum daily winter flow (January through March) is in excess of 8,000 cfs (USGS 2011). The average monthly flow below J.C. Boyle Dam from 1961-2009 was about 2,380 cfs in January, 2,450 cfs in February, and 2,890 cfs in March. Increasing the flow temporarily during reservoir drawdown by up to an additional 1,900 cfs over the No Action/No Project Alternative by removal of the stoplogs from the diversion culverts would not cause flood damage downstream. The concrete spillway crest structure would be removed once the reservoir water surface elevation was drawn down sufficiently, to provide additional flood release capacity and avoid reservoir refill. The embankment dam crest and left abutment wall would be retained for flood protection until removal.

Removal of the J.C. Boyle Dam embankment would begin at the end of May 2020. By then, the minimum reservoir drawdown level would have been achieved and inflow would have decreased to summer levels averaging less than 1,000 cfs. Within four to six weeks, the majority of the embankment would be removed except for a portion of the upstream toe which would serve as an upstream cofferdam. The upstream cofferdam would be armored with rockfill to allow a controlled breach between about water surface elevation 3758 and the channel bottom at elevation 3740, to fully drain the reservoir by July 2020. Reservoir releases would temporarily exceed inflow by up to approximately 5,000 cfs, depending upon the rate of breach development, but would remain below the downstream channel capacity. Although the breach flow would quickly attenuate as it moved downstream due to the very small reservoir volume, the Iron Gate cofferdam would be breached before breaching J.C. Boyle as a precaution.

Although limited drawdown of Copco 1 Reservoir would begin in November 2019 to permit early removal of the spillway gates and crest structure, the primary drawdown and sediment release of Copco 1 Reservoir would begin at the same time as the J.C. Boyle Dam reservoir drawdown in January 2020 and would be affected by the additional upstream releases. Average inflow to Copco 1 Reservoir would be no more than 100 cfs greater than normal streamflow for drawdown between reservoir water surface elevations 2590 feet and 2529 feet over a five to six week period, resulting in a total reservoir release from the diversion tunnel averaging up to 400 cfs above streamflow. A 10-year storm is estimated to result in flows of approximately 10,750 cfs (see Table 3.6-5), and the average daily flow has exceeded 9,000 cfs (USGS 2011).

The concrete dam would be removed in 8-foot lifts while the reservoir was being drawn down, removing concrete in the dry by blasting as the water surface elevation lowered. The diversion tunnel would pass the entire streamflow for as long as possible, but its discharge capacity would continue to decrease as the reservoir head is reduced. When additional discharge capacity is required, notches would be blasted in the concrete dam near the left abutment to allow for overtopping flows. The extent of notching would be affected by the water year type: wet years would require more notching than normal or dry years. The sudden increase in reservoir releases during notching may be controlled by reducing the diversion tunnel discharge if necessary. Drawdown between reservoir water surface elevations 2529 and 2484 would occur within 30 days. By March 12, 2020 the reservoir would be drained to the normal level of Copco 2 Reservoir (elevation 2484) and a large portion of the concrete dam would have been removed. The final portion of the concrete dam would be removed following drawdown of Copco 2 Reservoir and during the summer low flow period.

Copco 2 Dam does not provide any meaningful storage and the reservoir is very small compared to the other reservoirs, with little or no impounded sediment. Normal streamflow would be diverted downstream from Copco 2 Dam to the bypassed river reach beginning in mid-May 2020 when dam removal would begin. No additional releases would be made from the upstream reservoirs during this time as they would have already been mostly drained. The DRE would use cofferdams to isolate areas of the small concrete dam during demolition and would remove them once they were no longer needed.

Reservoir drawdown at Iron Gate Dam would occur simultaneously with reservoir drawdown at J.C. Boyle and Copco 1 Dams. Normal inflows to the reservoir in January and February 2020 would be increased by up to an estimated 500 cfs due to upstream reservoir drawdown releases. Reservoir drawdown between water surface elevations 2328 and 2202 would occur within a 10½-week period by controlled releases through the modified diversion tunnel, at an average drawdown rate of 3 feet per day. The maximum downstream flow during drawdown of Iron Gate Reservoir could exceed normal streamflow at the site by up to 1,800 cfs. The average monthly flow below Iron Gate Dam from 1961-2009 was about 2,830 cfs in January, 2,940 cfs in February, and 3,430 cfs in March (USGS 2011). A 10-year storm is estimated to discharge approximately 15,610 cfs (see Table 3.6-5), and average daily winter flows have exceeded 10,000 cfs (USGS 2011). Increasing the flow during reservoir drawdown by up to an additional 1,800 cfs would not cause flood damage downstream. The modified diversion tunnel discharge capacity would range between approximately 3,200 and 8,500 cfs during reservoir drawdown. Should a large flood event occur during drawdown, the outlet capacity would be exceeded and the reservoir could partially refill. This would be similar to existing operations during a flood event.

The Dam Removal Plan requires that sufficient freeboard be maintained for the dam embankment at all times to prevent potential flood overtopping and embankment failure. The amount of freeboard would be determined according to water year type and surface water elevation during removal operations. Excavation of the dam embankment would begin in June 2020, during a period of reducing streamflow and with a minimum reservoir release capacity of approximately 7,500 cfs. During this time, the embankment dam crest would be lowered 55 feet from elevation 2348 to elevation 2293. In July, excavation of the dam embankment would continue at an average rate of between 14,000 and 18,000 cubic yards per day, lowering the dam crest from elevation 2293 to elevation 2250, with a minimum reservoir release capacity of approximately 5,800 cfs. The majority of the dam embankment volume would be excavated during the following 8 weeks, while maintaining a portion of the upstream toe at elevation 2205 to serve as an upstream cofferdam. This would provide a minimum flood release capacity in excess of 3,000 cfs in both August and September, which is greater than the maximum historical streamflow during this period and far exceeds the average monthly flow rates for August and September of 980 cfs and 1,250 cfs, respectively (USGS 2011). By late September, the reservoir would be drawn down to the maximum possible extent, minimal streamflow would be occurring, and drawdown releases from upstream reservoirs would have ended. The upstream cofferdam would be armored with rockfill to allow a controlled breach between about water surface elevation 2189 and the channel bottom at elevation 2165, to fully drain the reservoir by September 2020. Reservoir releases would temporarily exceed inflow by up to approximately 5,000 cfs, depending upon the rate of breach development, but would remain below the downstream channel capacity. The breach flow would quickly attenuate as it moved downstream due to the very small reservoir volume. The upstream cofferdam at J.C. Boyle would not be breached until the natural river channel has been restored at the Iron Gate site.

This analysis uses the reservoir drawdown release rates at Iron Gate Dam to determine the level of significance of adverse impacts downstream because Iron Gate Dam has the largest reservoir, provides the highest amount of discharge, and is the most downstream of all of the dams that would be removed. The release rates that would occur during drawdown of the reservoir would be in accordance with the historical flow during an extremely wet year (1 percent exceedance capacity). Figure 3.6-5 shows historic and maximum flows at Iron Gate Dam under wet year, average year and dry year types. While the release rates that would occur during reservoir drawdown would be greater than the flows at the same time under the No Action/No Project Alternative, and in some months, above the historic monthly maximum flow (September), they would be lower than the overall peak flows in each reach. Because the flows would stay below historic peak flows, they would not change the floodplain or flood risks in comparison to the No Action/No Project Alternative. **Therefore, the impact from drawing down the reservoirs on flood risk would be less than significant.**

The release of sediment stored behind the dams and resulting downstream sediment deposition under the Proposed Action could result in changes to flood risks. Approximately 41 to 65 percent of sediment behind J.C. Boyle Dam, 46 to 81 percent of sediment behind Copco 1 Dam, and 25 to 38 percent of sediment behind Iron Gate Dam would be eroded and flushed down the river during removal activities (DOI 2011c). The remaining sediment would be left in place after dam removal above the active channel. The Lead Agencies conducted an analysis of future geomorphology and sediment transport during and after dam removal for dry, median and wet start year scenarios. Most of the erosion would occur during the drawdown period from January 1, 2020 to March 2020 and afterwards the river bed in the reservoir reaches is expected to stabilize. Minor deposition would occur in some of the reaches downstream of dam removal activities, however none is expected downstream of Shasta River (DOI 2011c). The Geology and Soils analysis considers the effects of sediment deposition in more detail (see Section 3.11.4.3). Sedimentation would occur downstream from the Four Facilities, but the quantity would vary depending on year type. The magnitude of sediment deposition is relatively small compared to sediment loading from other existing sources along the Klamath River. Additionally, the sedimentation would be short-term following dam removal. Because the sediment deposition would be short-term and small in comparison with the No Action/No Project Alternative, it would not affect stream characteristics in a way that would substantively affect flood inundation or flood risks. **Therefore, sediment deposition would have a less than significant effect on flood risk.**

Under the Proposed Action, the 100-year floodplain inundation area downstream of Iron Gate Dam could change between River Mile 190 and 171. Table 3.6-8 describes modeled flows on the Klamath River under the Proposed Action in wet water years (10 percent exceedance level) at multiple points on the river. These flows include all aspects of the Proposed Action, and the primary difference from the No Action/No Project Alternative is related to implementation of the KBRA. The bold numbers represent flows higher than the wet year flows under the No Action/No Project Alternative described in Table 3.6-6. Flows during wet years would be higher under the Proposed Action when compared to the No Action/No Project Alternative at all of these sites during the months of January and February and July to September. The Figures 3.6-7 to 3.6-11 graphically describe the comparisons in flows at 10, 50 and 90 percent flow exceedances between the No Action/No Project Alternative and the Proposed Action.

Table 3.6-8. Flood Flow Exceedance: Modeled Wet Water Year Flows on the Klamath River under the Proposed Action

	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.
Keno Dam	923	929	2,259	**3,258**	**4,349**	4,809	**4,845**	2,917	2,191	**1,465**	**920**	**1,067**
J.C. Boyle Dam	1,160	1,117	2,508	**3,481**	**4,562**	5,189	**5,233**	3,399	2,544	**1,780**	**1,155**	**1,320**
Iron Gate Dam	1,304	1,305	2,908	**4,192**	**5,219**	5,957	**5,960**	**3,966**	2,806	**1,939**	**1,292**	**1,449**
Seiad Valley	1,770	3,196	**8,319**	**11,090**	**10,803**	**11,025**	9,904	**8,509**	6,124	**3,018**	**1,695**	**1,724**
Orleans	3,195	10,153	**27,098**	**30,998**	**22,727**	**26,485**	**19,973**	**18,614**	12,629	**4,993**	**2,574**	**2,306**

Notes:
Bold numbers represent flows that are greater than the No Action/No Project Alternative.

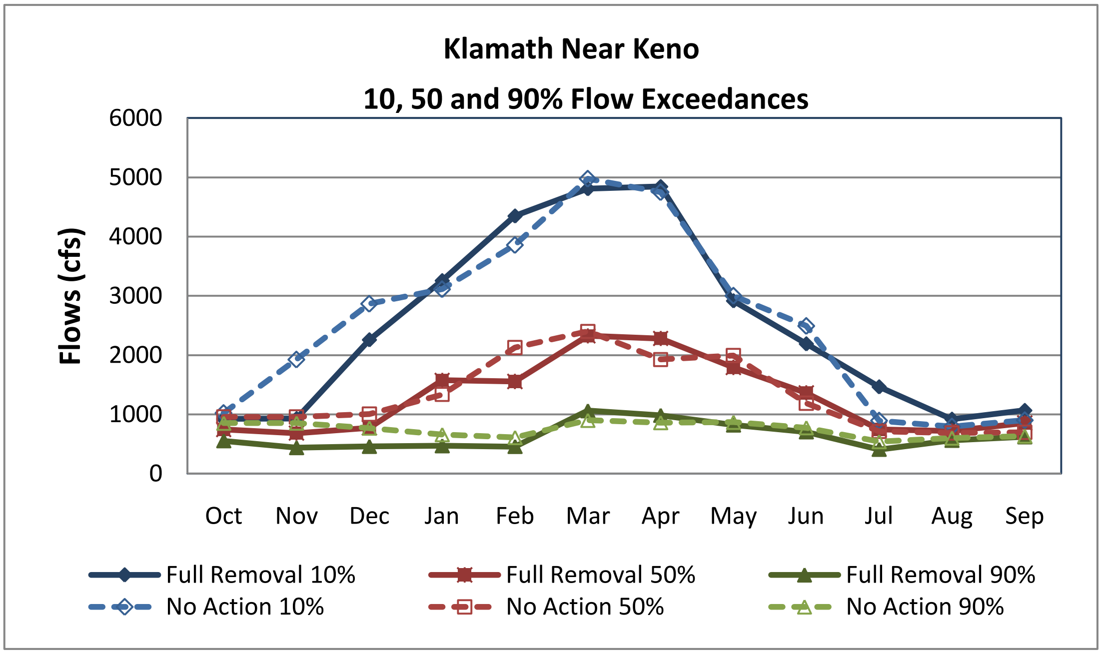


Figure 3.6-7. Modeled Flow Exceedances under the No Action/No Project Alternative and Proposed Action Near Keno Dam

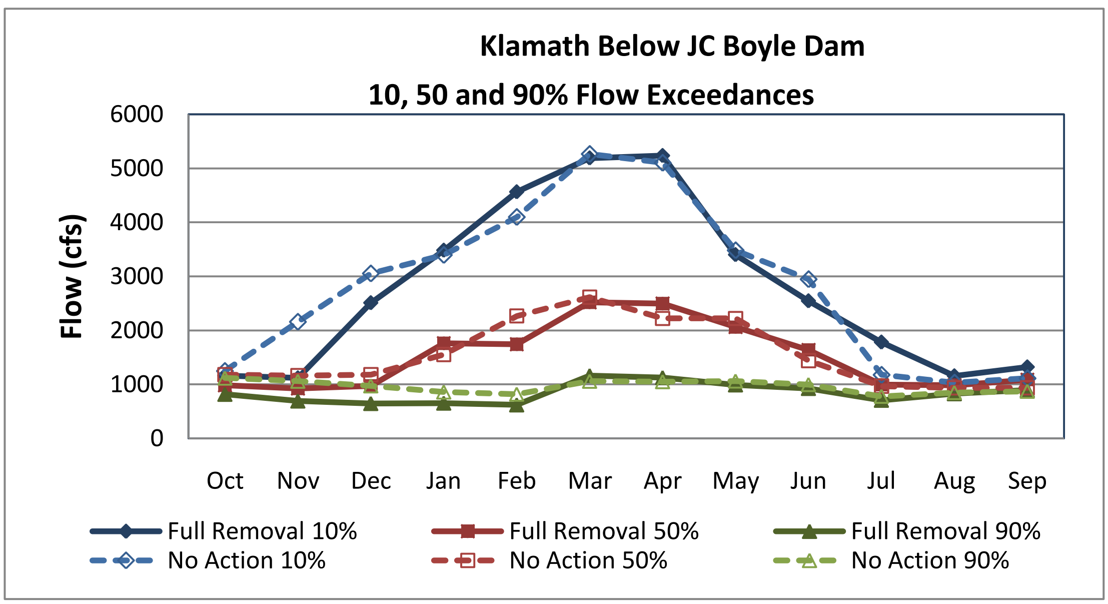


Figure 3.6-8. Modeled Flow Exceedances under the No Action/No Project Alternative and Proposed Action Below J.C. Boyle Dam

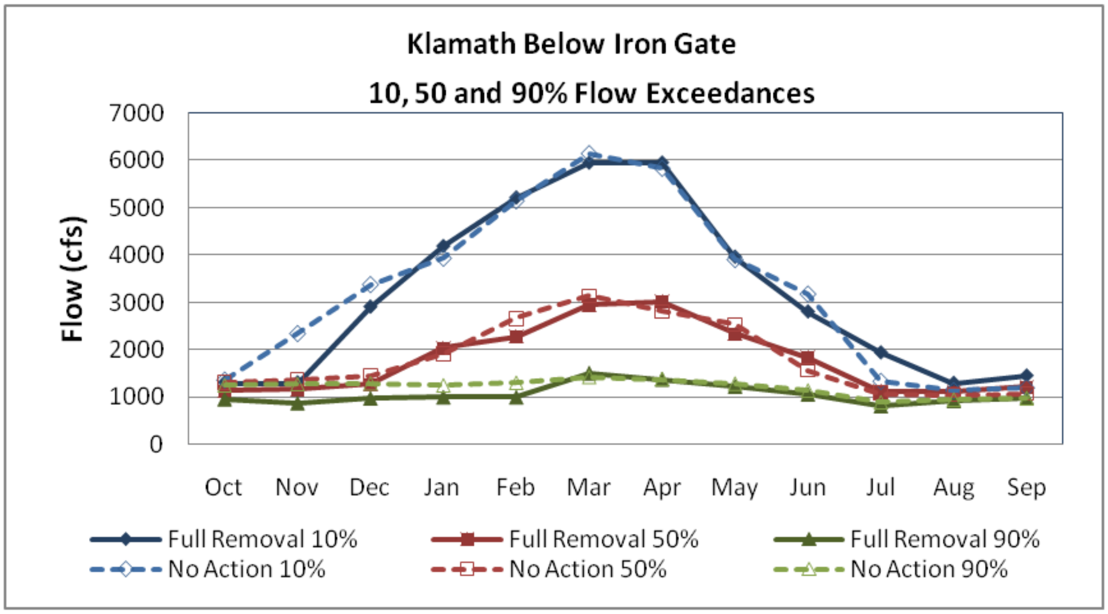


Figure 3.6-9. Modeled Flow Exceedances under the No Action/No Project Alternative and Proposed Action Below Iron Gate Dam

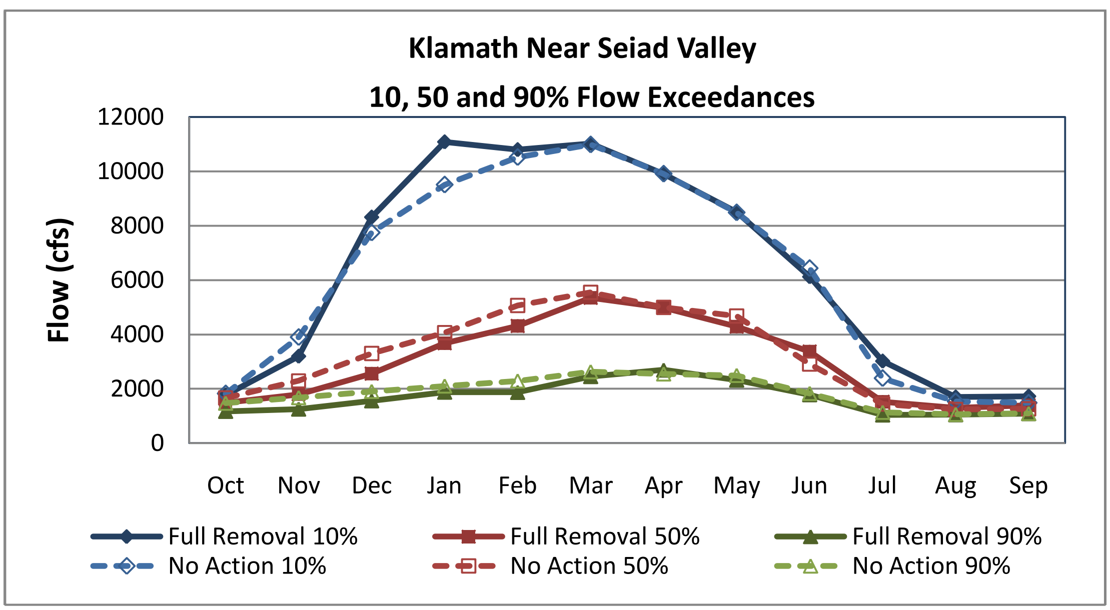


Figure 3.6-10. Modeled Flow Exceedances under the No Action/No Project Alternative and Proposed Action Near Seiad Valley

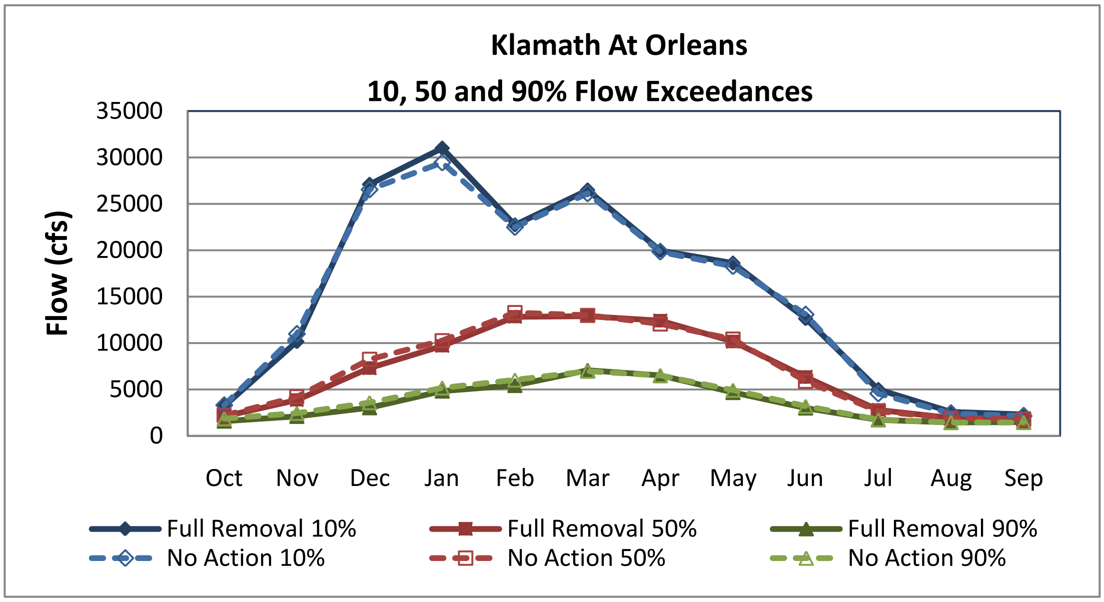


Figure 3.6-11. Modeled Flow Exceedances under the No Action/No Project Alternative and Proposed Action at Orleans

J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams provide only incidental flood protection during flood events. Table 3.6-9 shows peak flood flows and shows flood attenuation of less than 5 percent would have been provided by Iron Gate and Copco 1 Dams under the No Action/No Project Alternative. (J.C. Boyle and Copco 2 Dams have negligible capacity for flood attenuation.) Under the Proposed Action, the facilities would not be in place to provide this temporary reduction in flow.

Table 3.6-9. Flood Attenuation of Iron Gate and Copco 1 Reservoirs

Flood	Peak Flow No Action	Peak Flow Under the Proposed Action	% Reduction With Dams In
Synthetic 100-yr flood	31,460	33,800	6.9
1989	10,200	10,300	1.2
1993	11,100	11,400	2.7
1996	11,200	11,300	1.1
1997	20,500	21,400	4.0
2005	12,400	12,800	3.0

Source: DOI 2011c

Appendix J includes model results that show flood maps for the river reaches below Iron Gate Dam to Happy Camp. The series of figures show the 100-year floodplain under the No Action/No Project Alternative and the Proposed Action; the differences between the two floodplains are very minor. As described under No Action/No Project Alternative analysis, there are some differences in the current 100-year flood inundation areas between FEMA and the model. These differences are attributable to the use of different base data and the use of enhanced elevation data by the Lead Agencies. FEMA is in the process of updating FIRMs using enhanced elevation data but has not accomplished this near the Klamath River.

DOI determined the existing floodplain by computing the 100 year flood and then mapping the extent of that floodplain on the existing topography. The existing floodplain may be different than that proposed by FEMA because it is based upon more current information. DOI also determined the 100-yr floodplain after dam removal. Based upon the most current inventory of structures downstream of Iron Gate Dam to Humbug Creek over 24 residences are within the existing 100 year flood plain. Less than 6 residences and other structures such as garages are outside of this flood plain, but may be put into the 100 year floodplain after removal of the dams. However, the final determination of the future 100-yr floodplain after dam removal will be made by FEMA. The purpose of the analysis was to estimate the costs to mitigate the increase in flood risk. The existing bridges are within the 100-year floodplain; however, these structures would need to be evaluated to determine if they would still maintain enough clearance to not be inundated by flooding. Not all of the structures that could be exposed to increased flooding risks are permanent. However, an increase in risk to one habitable structure or bridge is considered to be significant according to the significance criteria. Mitigation measures H-1 and H-2 are described below.

Modeled flows represent average monthly conditions, but peak flows for fisheries and storms could result in greater flows for a short duration. Table 3.6-9 shows the flood attenuation during a 100-year storm, and the dams provide an even smaller percent attenuation during a peak flow event. During high flow periods, the existing flood control capacity with the four dams would do little to reduce flood damage. Therefore, there would be little change to flood control capacity after the four dams are removed.

When a large flood event is predicted, the National Weather Service provides river stage forecasts for the Klamath River for the USGS gages at Seiad Valley, Orleans and Klamath. They currently do not publish a forecast for river stage at Iron Gate gage. However, they work with PacifiCorp to issue flood warnings to Siskiyou County. After removal of Copco and Iron Gate Dams, it is likely that National Weather Service will publish a forecast at the Iron Gate gage location (DOI 2011c).

Both Klamath County (Klamath County 2010b) and Siskiyou County participate in the NFIP and rely on existing 100-year flood maps prepared by FEMA to plan for future development or management near flood prone areas. Regulations under the NFIP require participating communities to "inform FEMA of any physical changes that affect 100-year flood elevations…within 6 months of the date that such data are available." This information is submitted in the form of a LOMA-F or LOMR by the community. FEMA will review the submitted data and determine if a map revision is warranted and proceed accordingly (FEMA 2002). Removal of the four dams would change the 100-year flood inundation zone when compared to the current FEMA map. This would require either a LOMA-F or LOMR to be prepared by Klamath and Siskiyou Counties for areas within their jurisdictions. Both counties might require the DRE or other responsible agency to work with them to prepare the application. In Klamath County, the FEMA 100-year flood inundation area would change due to removal of J.C. Boyle Reservoir.

The change to the 100-year floodplain inundation area downstream from Iron Gate Dam would increase the risks of flooding structures; therefore, the impact on flood hydrology would be significant. Mitigation Measures H-1 and H-2 would reduce the impact to flood hydrology to less than significant.

Removing the Four Facilities could reduce the risks associated with a dam failure. The Four Facilities, collectively, store over 169,000 acre-feet of water when they are full. The dams are inspected regularly, and the probability for failure has been found to be low. However, if a dam failed, it could inundate a portion of the downstream watershed (Siskiyou County website 2011). Removing the Four Facilities would eliminate the potential for dam failure and subsequent flood damages. **Therefore, eliminating the dam failure risk associated with the Four Facilities would have a beneficial effect on flood hydrology.**

The relocation of the Yreka water supply pipeline could affect river flows and result in changes to flood risks. The existing water supply pipeline for the City of Yreka passes under the Iron Gate Reservoir and would have to be relocated prior to the decommissioning of the reservoir to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline could either be suspended from a pipe bridge across the river near its current location, or rerouted along the underside of the Lakeview Bridge just downstream of Iron Gate Dam. The pipe bridge would be located above the 100 year flood line as the intention is to prevent the pipeline from being exposed to high velocity flows. Thus, the pipe bridge would not affect flood hydrology. If the pipeline was placed on the Lakeview Bridge, there would be no effect to flood hydrology from the placement of the pipeline that would be directly caused by the pipeline separate from the bridge. **Therefore, there would be no change from existing conditions from flood risk from the relocation of the Yreka water supply pipeline.**

Under the Proposed Action, recreational facilities currently located on the banks of the existing reservoirs would be removed following drawdown and could change flood hydrology. The existing recreational facilities provide camping and boating access for recreational users of the reservoirs. Once the reservoirs are drawn down, these facilities would be removed. These facilities would be well above the new river channel, and deconstruction would not place anything in the channel or otherwise impeded low or high flows in the Klamath River. **Therefore, there would be no change from existing conditions from flood hydrology from the removal of the recreational facilities.**

Keno Transfer

Implementation of the Keno Transfer could cause changes to operations affecting flows downstream of Keno Dam, which could cause changes to flood risks. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on flood hydrology compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice. **Implementation of the Keno Transfer would have no change from existing conditions from flood risks.**

East and West Side Facilities

Decommissioning the East and West Side Facilities could cause changes in flood risk downstream of the facilities. Decommissioning of the East and West Side canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA will redirect water flows currently diverted at Link River Dam into the two canals, back in to Link River. Following decommissioning of the facilities there will be no change in outflow from Upper Klamath Lake or inflow into Lake Ewauna. **Therefore, implementation of the East and West Side Facility Decommissioning action would result in no change from existing conditions.**

KBRA

The KBRA, which is a component of the Proposed Action, encompasses several programs that could affect flood hydrology, including:

- Phases I and 2 Fisheries Restoration Plan
- Wood River Wetland Restoration
- Future Storage Opportunities
- On-Project Plan
- Water Use Retirement Program
- Emergency Response Plan
- Water Diversion Limitations
- Climate Change Assessment and Adaptive Management
- Interim Flow and Lake Level Program

Phases 1 and 2 Fisheries Restoration Plans

Implementation of the Fisheries Restoration Plans could change flows downstream of Upper Klamath Lake, which could result in changes to flood risks. Actions within the floodplain and river channel including: floodplain rehabilitation, large woody debris replacement, fish passage correction, cattle exclusion fencing, riparian vegetation planting, and treatment of fine sediment sources could alter river hydraulics. The restoration actions are designed to improve aquatic and riparian habitat and the potential changes in river hydraulics are intended to improve the habitats' ability to support river fisheries. Changes in river hydraulics could generate minor changes in flood risks in and around the specific restoration locations. The timing of and specific locations where these resource management actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. **However, potential changes in river hydraulics are likely to generate a less than significant impact to flood risks. Implementation of specific plans and projects outlined in the Fisheries Restoration Plans will require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

Wood River Wetland Restoration
Implementation of Wood River Wetland Restoration may change flows upstream and downstream of Upper Klamath Lake, which could result in changes to flood risks. A study of future Wood River Wetland area management options would be conducted to provide additional water storage for a total of 16,000 acre-feet of storage capacity in or adjacent to Agency Lake. This additional storage upstream of Upper Klamath Lake is likely to decrease potential flood risks downstream of Upper Klamath Lake by potentially storing excess flows. The improvements in flood risk generated by implementation of the Wood River Wetland Restoration Project would not be expected to contribute to the effects of hydroelectric facility removal analyzed above. **Implementation of the Wood River Wetland Restoration Project is anticipated to have a beneficial effect on flood risks. Implementing Wood River Wetland Restoration will require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

Future Storage Opportunities
Implementation of Future Storage Opportunities by Reclamation may cause changes to flows upstream and down downstream of Upper Klamath Lake, which could result in changes to flood risks. Reclamation plans to identify and study additional off-stream storage opportunities with a 10,000 acre-feet of storage milestone in implementation of KBRA. Offstream storage is likely to decrease potential flood risks by potentially storing excess flows. The improvements in flood risk generated by development of off-stream storage would not be expected to contribute to the effects of hydroelectric facility removal analyzed above. **Implementation of Future Storage Opportunities is anticipated to have a beneficial effect on flood risks. Implementing Future Storage Opportunities will require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

On-Project Plan
Implementation of the On-Project Plan may change flows downstream of Upper Klamath Lake during dry years, which could result in changes to flood risks. The On-Project Plan supports full implementation of Water Diversion Limitations by taking actions to reduce water use for irrigation. These actions include: land fallowing and shifting to dryland crop alternatives, changes in land use and forage availability/types for terrestrial species, efficiency and conservation measures (i.e. drip irrigation), development of groundwater sources, or creation of additional storage. Reductions in water use under the On-Project Plan would not be expected to contribute to any changes in flood risk generated by the hydroelectric facility removal action. **Implementation of the On-Project Plan is likely to generate no change in flood risk when compared to existing conditions as it would be implemented during dry years during the irrigation season when flood risks are**

low. Implementing the On-Project Plan will require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.

Water Use Retirement Program (WURP)

Implementation of the WURP would change flows upstream of Upper Klamath Lake, which could result in changes to flood risks. The WURP is a voluntary program for the purpose of supporting fish populations restoration by permanently increasing inflow to Upper Klamath Lake by 30,000 acre-feet per year. A variety of management measures and irrigation water use changes would help to accomplish an inflow increase and are described in Section 2.4.3.9. Upper Klamath Lake storage has already increased after breaching of levees and dikes by the Williamson River Delta project which would be large enough to accommodate the inflow increase. Other KBRA measures described below would manage outflow to the Klamath River. Reductions in water use under the WURP would not be expected to contribute to any changes in flood risk generated by the hydroelectric facility removal action. **Implementation of the WURP is expected to generate no change in flood risks when compared to existing conditions because flow changes would be implemented during the irrigation season and not the flood season. Implementing the WURP will likely require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

Emergency Response Plan

Implementation of an Emergency Response Plan could result in changes to flood risks in the event of failure to a Klamath Reclamation Project facility or dike on Upper Klamath Lake or Lake Ewauna. The purpose of the plan is to prepare water managers for an emergency affecting the storage and delivery of water needed for KBRA implementation. The components of the Emergency Response Plan are described in Section 2.4.3.9 and include potential emergency response measures and processes to implement emergency responses. While use of an Emergency Response Plan could potentially reduce damage to property or loss of life due to a facility or dike failure, the intent of this plan is to allow for continued storage and delivery of water according to KBRA commitments and would not affect the probability of experiencing a flood. Additionally the Emergency Response Plan would not be expected to contribute to any changes in flood risk generated by the hydroelectric facility removal action. **Therefore, it is anticipated that implementation of the Emergency Response Plan would generate no change in flood risk when compared to existing conditions, although it would likely help to reduce damage to property or loss of life due to a flood event which would be a beneficial effect to flood risks. Implementing the Emergency Response Plan will likely require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

Climate Change Assessment and Adaptive Management

Implementation of Climate Change Assessment and Adaptive Management may change flows upstream and downstream of Upper Klamath Lake, which could result in changes to flood risks. One of the main purposes of Climate Change Assessment and Adaptive Management is to respond to and protect basin interests from the adverse affects of climate change. Flood risks could be adversely impacted due to climate changes which increase river flows and/or flooding frequency. Klamath Basin Parties including technical experts would be involved in the development of assessment and adaptive management strategies. Assessments and development of adaptive management strategies would be implemented continuously to respond to predicted climate changes. The improvements in flood risk generated by the Climate Change Assessment and Adaptive Management Program would be expected improve the effects of hydroelectric facility removal analyzed above. **While flood risks could be adversely impacted by climate change in general, implementation of Climate Change Assessment and Adaptive Management would help to reduce flood risks in the event of climate changes and be beneficial to flood risks. Implementing Climate Change Assessment and Adaptive Management will likely require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

Interim Flow and Lake Level Program

Implementation of Interim Flow and Lake Program during the interim period would change river flows, which could result in changes to flood risks. The goal of the Interim Flow and Lake Level Program is to "further the goals of the Fisheries Program" during the interim period. This would require changes in flows to accommodate fish needs during the irrigation season. These flow changes would be similar to what is currently recommended under biological opinions. Changes in water flows under the Interim Flow and Lake Level Program would not be expected to contribute to any changes in flood risk generated by the hydroelectric facility removal action. **Therefore, implementation of the Interim Flow and Lake Level Program would cause no change in flood risk from existing conditions because flow changes would not be implemented during the flood season.**

Alternative 3: Partial Facilities Removal of Four Dams

Under the Partial Facilities of Four Dams Alternative, impacts would be the same as for the Proposed Action. **The increased flood risks would be less than significant. The change in the 100-year floodplain downstream from Iron Gate Dam would increase the risks of flooding structures and would be significant. Mitigation measures H-1 and H-2 would reduce this impact to less than significant. Eliminating the dam failure risk would have a beneficial effect.**

Keno Transfer

The flood hydrology impacts of the Keno Transfer under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

East and West Side Facilities

The surface water and hydrology impacts of the decommissioning the East and West Side canals under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action**.**

KBRA

Under this alternative, the KBRA would be fully implemented and the potential effects would be the same as described for the Proposed Action. **Implementation of the KBRA would result in a less than significant impact to flood hydrology.**

Alternative 4: Fish Passage at Four Dams

Under the Fish Passage at Four Dams Alternative, flows downstream of Iron Gate Dam would remain the same as for the No Action/No Project Alternative. The risk of dam failure and downstream flooding would be the same as under the No Action/No Project Alternative and existing condition. Within the Hydroelectric Reach, however, flows would change to accommodate the new fish ladders and requirements within the bypass reaches. Flows within the J.C. Boyle Bypass Reach would increase to meet fish needs in this area. Although the flows would increase compared to the No Action/No Project Alternative, the existing channel capacity is adequate to accommodate these increases. Flows downstream of Iron Gate Dam would not change. **Therefore, the effects from Fish Passage at Four Dams Alternative on flood hydrology would be less than significant because the river channel capacity can support flow increases and there would be no increased risks of flooding.**

Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Drawdown of reservoirs could result in short-term increases in downstream surface water flows and result in changes to flood risks. Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, short-term drawdown of reservoirs would occur at Copco 1 and Iron Gate dams, with the same effects as for the Proposed Action. No drawdown would occur in Klamath County because J.C. Boyle Reservoir would remain in place. As described in the Proposed Action, **drawdown-related impacts to flood risks for the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less than significant because flow changes would be within the historic range.**

The release of sediment stored behind Copco 1 and Iron Gate dams and resulting downstream sediment deposition could result in changes to flood risks. Approximately 46 to 81 percent of sediment behind Copco 1 Dam, and 25 to 38 percent of sediment behind Iron Gate Dam would be eroded and flushed down the river during removal activities (DOI 2011c). As was described and analyzed above for the Proposed Action, the magnitude of sediment deposition is relatively small compared to sediment loading from other existing sources along the Klamath River. Additionally, the sedimentation would be short-term following dam removal. Because the sediment deposition would be short-term and small in comparison with the No Action/No Project Alternative, it would not affect stream characteristics in a way that would substantively affect flood inundation or flood risks. **Therefore, sediment deposition would have a less than significant effect on flood risks.**

The 100-year floodplain inundation area downstream of Iron Gate Dam could change between River Mile 190 and 105 (study area). Removing Copco 1 and Iron Gate would result in a change in flows downstream of Iron Gate Dam. These changes would be less than the Proposed Action, but could result in flooding to some structures in the 100-year floodplain. Additionally, flow requirements in the J.C. Boyle Bypass Reach would increase flows, but similar to the Fish Passage at Four Dams Alternative, these changes would be within the historic range of flows in this reach. **The change to the 100-year floodplain inundation area downstream from Iron Gate Dam would increase the risks of flooding structures; therefore, the impact on flood hydrology would be significant. Mitigation measures H-1 and H-2 would reduce the impact to flood hydrology to less than significant.**

Removing Copco 1 and Iron Gate Dams could reduce the risks associated with a dam failure. Copco 1 and Iron Gate Dams together store over 90,000 acre-feet of water when they are full. The dams are inspected regularly, and the probability for failure has been found to be low. However, if a dam failed, it could inundate a portion of the downstream watershed (Siskiyou County website 2011). Removing the dams would eliminate the potential for dam failure and subsequent flood damages. J.C. Boyle Dam would still be in place, and the potential for dam failure would be the same as in the No Action/No Project. The inundation area, however, could change because removal of the downstream facilities would affect flow patterns. **Overall, eliminating the dam failure risk associated with Copco 1 and Iron Gate Dams would have a beneficial effect on flood hydrology.**

The relocation of the Yreka water supply pipeline could affect river flows and result in changes to flood risks. Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, relocation of the Yreka water supply pipeline would occur at Iron Gate dam, with the same effects as for the Proposed Action. As described in the Proposed Action, **there would be no change from existing conditions from flood risks from the relocation of the Yreka water supply pipeline.**

Recreational facilities currently located on the banks of Iron Gate and Copco reservoirs would be removed following drawdown and could change flood hydrology. Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, recreation facilities would be removed at Iron Gate and Copco reservoirs, with the same effects as for the Proposed Action. **Therefore, there would be no change from existing conditions flood hydrology from the removal of the recreational facilities.**

Construction of a new gage within the 100-year floodplain at Copco 2 Dam or J.C. Boyle Dam to measure flows could affect flood hydrology. Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative a new gage would need to be developed at Copco 2 Dam or J.C. Boyle Dam to measure flows required to protect fish habitat downstream. Incorporation of environmental measures in the project would avoid construction-related impacts from construction in the floodplain. **The construction of a new gage would be a less than significant impact.**

Changes in flows in the Hydroelectric Reach including the J.C. Boyle and Copco 2 bypass Reaches could affect flood hydrology. Similar to the analysis stated under the Fish Passage at Four Dams Alternative, flows would change to accommodate the new fish ladders and requirements within the bypass reaches. As stated under the Fish Passage at

Four Dams Alternative, **the effects on flood hydrology would be less than significant because the river channel capacity can support flow increases and there would be no increased risks of flooding.**

3.6.4.4 Mitigation Measures

Mitigation Measure by Consequence Summary

Mitigation Measure H-1: Prior to dam removal, the DRE will inform the National Weather Service, River Forecast Center, of a planned major hydraulic change (removal of four dams) to the Klamath River that could potentially affect the timing and magnitude of flooding below Iron Gate. The River Forecast Center is the federal agency that provides official public warning of floods. As needed, the River Forecast Center would update their hydrologic model of the Klamath River to incorporate these hydraulic changes so that changes to the timing and magnitude of flood peaks would be included in their forecasts. As currently occurs, flood forecasts and flood warnings would be publicly posted by the River Forecast Center for use by federal, state, county, tribal, and local agencies, as well as the public, so timely decisions regarding evacuation or emergency response could be made.

Prior to dam removal, the DRE will inform FEMA of a planned major hydraulic change to the Klamath River that could affect the 100-year flood plain. The DRE will ensure recent hydrologic/hydraulic modeling, and updates to the land elevation mapping, will be provided to FEMA so they can update their 100-year flood plain maps downstream of Iron Gate Dam (as needed), so flood risks (real-time and long-term) can be evaluated and responded to by agencies, the private sector, and the public.

Mitigation Measure H-2: The DRE will work with willing landowners to move or relocate permanent, legally established, permitted, habitable structures in place before dam removal. The DRE will move or elevate structures where feasible that could be affected by changes to the 100-year flood inundation area as a result of the removal of the Four Facilities.

Effectiveness of Mitigation in Reducing Consequence

These mitigation measures will be effective as they will identify the extent of the increased flood risks and take measures which will reduce the risks for loss, injury or death from flooding.

Agency Responsible for Mitigation Implementation

The DRE would be responsible for implementing mitigation measures H-1 and H-2.

Mitigation Measures Associated with Other Resource Areas

Implementation of Mitigation REC-1 would create a plan to develop recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoir is removed. These facilities will not contribute to channelization of the river and thus increase flood risks, or create infrastructure in the flood plain that would be at risk of damage during inundation. **Therefore, there would be no change from existing conditions to Flood Hydrology from the implementation of REC-1.**

3.6.5 References

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